FINAL REPORT

Assessing and Controlling Blast Noise Emission

ESTCP Project SI-0006

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14. ABSTRACT

SARNAM™ was used to assess the noise emission from a proposed new firing range, and to explore options to reduce community noise impact. Options were identified that provided 5 to 10 dB reductions. SARNAM™ was shown to reduce the labor and cost of small arms noise analysis by 65%. SARNAM™ was validated by comparing noise level predictions with comprehensive measurements of noise from an active military range over a time period of several months. The accuracy of noise dose quantification was shown to be acceptable, much more reliable than can be obtained by short-term monitoring because of the large variance in received noise level due to weather conditions. Significantly, the validation effort clarified the need for improved methods of noise impact assessment.

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Acronyms

ANSI	American National Standards Institute
AR	Army Regulation
ARNG	Army National Guard
ASEL	A-weighted Sound Exposure Level
BNOISE2™	Blast Noise 2 software
CDNL	C-weighted Day-Night average sound level
CERL	Construction Engineering Research Laboratory
DA PAM	Department of the Army Pamphlet
dB	decibel
DNL	Day-Night Level
DOCALC	a calculation engine
DoD	Department of Defense
EQT	Environmental Quality Technology
ERDC	Engineer Research and Development Center
ESTCP	Environmental Security Technology Certification Program
ETMP	Environmental Technology Management Plan
FICUN	Federal Interagency Committee of Urban Noise
FY	Fiscal Year
GIS	Geographic Information System
GUI	Graphical User Interface
INMP	Installation Noise Management Program
IL	Illinois
LEQ	Equivalent Sound Level
MPMG	Multi-Purpose Machine Gun (range)
NEPA	National Environmental Policy Act
NMPlot	Noise Map Plot
ONMP	Operational Noise Management Plan
QA/QC	Quality Assurance/Quality Control
R&D	Research and Development
RFMSS	Range Facilities Management Scheduling System
SARNAM™	Small Arms Range Noise Assessment Model software
SE	Sound Exposure
SEL	Sound Exposure Level
SPL	Sound Pressure Level
T&ES	Threatened and Endangered Species
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USMC	US Marine Corps
UTM	Universal Transverse Mercator

Acknowledgements

This project to demonstrate and validate small arms noise impact assessment software was jointly executed by the Acoustics Team of Engineer Research and Development Center / Construction Engineering Research Laboratory (ERDC/CERL) at Champaign, IL, and the Operational Noise Program of the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM). We thank the Illinois Army National Guard (IL ARNG) range personnel and Mr. Jon Casebeer for facilitating data acquisition at the Marseilles Training Site. We thank Ms. Catherine Stewart, Dr. George Luz, and Dr. Robert Holst for their comments and suggestions. This work could not have been accomplished without the initiative and field assistance of Mr. Jeffery Mifflin in collecting and managing the small arms range noise data. The project was supported by the Environmental Security Technology Certification Program (ESTCP), Dr. Jeffrey Marqusee, Director, and Dr. Robert Holst, the former Sustainable Infrastructure Program Manager; and Dr. John Hall, Sustainable Infrastructure Program Manager.

Executive Summary

Weapons noise compromises the Department of Defense (DoD) ability to maintain access to resources necessary for military training and testing. Community reactions to excessive military noise include complaints, damage claims, legal action, political pressure, and other efforts to curtail the noisy activity. Noise concerns have prompted installations to relocate training, impose firing curfews, and close ranges. Such short-term-solution decisions, if made without reliable noise management guidance, can needlessly hamper training mission execution and ultimately impact Soldier proficiency and survival. Noise impact assessment software also guides planning decisions to minimize noise impacts on Soldier and civilian health and welfare. Impulsive noise from weapons training and testing is not governed by national laws; consequently, noise management consists of striking a balance between mission execution and environmental quality. Reliable guidance regarding noise level reduction under a wide range of conditions is arguably more important than the absolute accuracy of noise level predictions for specific conditions.

The military noise impact assessment software, or noise model, known as SARNAM™ enables calculation and display of noise contours for small arms ranges. The name SARNAM™ is an acronym for Small Arms Range Noise Assessment Model. Input options include the type of weapon and ammunition, number and time of shots, range size and structure, noise dose metrics, and assessment protocols. The model accounts for muzzle blast and projectile sonic boom spectrum and directivity, which facilitates accurate sound level prediction and interpretation of receiver response. SARNAM™ noise level predictions are based on the mean expected value of noise level metrics for mild downwind sound propagation conditions; this calculation is used in all directions, which moderately over-predicts noise levels in some regions. SARNAM™ is most useful as an environmental planning tool to address unwanted noise as an environmental attribute in the community; it can be used to avoid siting new noise-sensitive land uses in areas impacted by military noise and to guide mitigation of environmental impacts of operational plans or new facilities. Implementation cost of this Army in-house-developed software consists essentially of learning to use the software, which is facilitated by expertise in acoustics and familiarity with military weapons systems and training procedures.

This project evaluated the accuracy, effectiveness, and cost advantages of the SARNAM™ noise impact assessment software. For the purposes of this report, “demonstration” refers to the use of computer software to calculate and display noise contour and does not include field monitoring; “validation” refers to the field monitoring performed at Marseilles Training Site to determine noise prediction accuracy.

The validation aspect of this project tested the accuracy of SARNAM™ noise contours. Each element of the application, particularly sound calculation algorithms, had been validated under controlled conditions prior to the present project. This project tested the software package predictions in a realistic situation by measuring community noise levels in small arms training scenarios at the Illinois Army National Guard’s (IL ARNG) Marseilles Training Area; measured levels were compared with SARNAM™ calculated results. Every noise event that exceeded a threshold was measured as a datum and was also recorded and later verified to be shooting noise data by listening to the recordings; many extraneous sound events, for example due to farm machinery, animals, and weather events, were thereby excluded. These procedures helped to

ensure an extensive and reliable set of noise monitor data. Conduct of the validation project was complicated by problems with the noise monitoring instruments used to collect the field data, which heavily impacted project schedule and costs. Additional difficulties encountered were associated with training schedule and workload changes resulting from the September 11, 2001, terrorist attack, changes in Army structure, and military deployments to Afghanistan and Iraq. The goal of agreement within 5 dB was not met; the lack of agreement was due to several factors. The monitoring period was cut short by an unexpected closure of the ranges; only summer, not the typically more noisy winter, weather conditions were sampled. Analysis of the data pointed up the critical consequences of inaccurate range firing data for determining calculated metric values, particularly long-term averages. The results of the validation support the need for an option in SARNAM™ to select from among a variety of weather classifications, rather than the current downwind-only model, to achieve improved accuracy under a greater available selection of weather conditions. The results emphasize that, given the always-present uncertainties in propagation conditions and operation parameters (e.g., weapon, location, and the number of shots) that influence sound level predictions, it is not reasonable to expect agreement between predictions and spot measurements. The software is most useful for determining the noise environment ramifications of changes in facilities and operations; these effects are valid regardless of uncertainties and ephemeral weather conditions. Significantly, the validation effort clarified the need for improved methods of noise impact assessment.

The demonstration aspect of the project evaluated the utility of SARNAM™ in dealing with realistic operational noise problems. The software was used to assess the noise emission from a proposed new firing range, and to explore and evaluate options to reduce community noise impact, as part of an actual installation-requested noise consultation. Options were identified that provided 5 to 10 dB reductions in community noise level, which exceeded the project goal of a 5 dB reduction, by moving the range location and adding noise barriers. Prior to SARNAM™ the only way to assess small arms noise impact was by manual hand calculation of the expected noise environment in combination with on-site noise monitoring. SARNAM™ was shown to reduce the labor and cost of small arms noise analysis by 65%, which significantly exceeds the 20% cost reduction goal. SARNAM™ was demonstrated to be an effective and economical means for reducing community noise to help maintain combat training throughput.

1. Introduction

1.1 Background

Weapons noise compromises the Department of Defense (DoD) ability to maintain access to resources necessary for military training and testing. Community reactions to excessive military noise include complaints, damage claims, legal action, political pressure, and other efforts to curtail the noisy activity. Noise concerns have prompted installations to relocate training, impose firing curfews, and close ranges. Such short-term-solution decisions, if made without reliable noise management guidance, can needlessly hamper training mission execution and ultimately impact Soldier proficiency and survival. Noise impact assessment software also guides planning decisions to minimize noise impacts on Soldier and civilian health and welfare. Impulsive noise from weapons training and testing is not governed by national laws; consequently, noise management consists of striking a balance between mission execution and environmental quality. Reliable guidance regarding noise level reduction under a wide range of conditions is arguably more important than the absolute accuracy of noise level predictions for specific conditions.

The military noise impact assessment software, or noise model, known as SARNAM™ enables calculation and display of noise contours for small arms ranges. The name SARNAM™ is an acronym for Small Arms Range Noise Assessment Model. Input options include the type of weapon and ammunition, number and time of shots, range size and structure, noise dose metrics, and assessment protocols. The model accounts for muzzle blast and projectile sonic boom spectrum and directivity, which facilitates accurate sound level prediction and interpretation of receiver response. SARNAM™ noise level predictions are based on the mean expected value of noise level metrics for mild downwind sound propagation conditions; this calculation is used in all directions, which moderately over-predicts noise levels in some regions. SARNAM™ is most useful as an environmental planning tool to address unwanted noise as an environmental attribute in the community; it can be used to avoid siting new noise-sensitive land uses in areas impacted by military noise and to guide mitigation of environmental impacts of operational plans or new facilities. Implementation cost of this Army in-house-developed software consists essentially of learning to use the software, which is facilitated by expertise in acoustics and familiarity with military weapons systems and training procedures.

1.2 Objectives of the Demonstration

The overall goal of this demonstration/validation project was to evaluate the accuracy, effectiveness, and cost performance of the SARNAM™ noise impact assessment software. In this report, “demonstration” refers to the use of the software to calculate and display noise contours and does not include field monitoring; “validation” refers to the field monitoring performed to determine noise prediction accuracy. The objective of the validation aspect of the project was to test the accuracy of SARNAM™ by comparing calculation results with comprehensive noise monitor data to judge noise level prediction accuracy. The objective of the demonstration aspect of the project was to evaluate the software utility and cost during realistic noise management consultation. The software was used to predict noise contours associated with the operation of a proposed new range, and was then used to explore revisions to the range location and design to reduce the noise level in the adjacent community. The primary performance measures were the amount of noise dose reduction, the cost of use, and the projected cost savings.

1.3 Regulatory Drivers

Department of the Army Pamphlet (DA PAM) 200-1 (2002) stipulates requirements and procedures for assessing training noise impacts. Noise contours are required for an Operational Noise Management Plan (ONMP) mandated by Army Regulation (AR) 200-1 version published in 1997 and revised in 2007. The National Environmental Policy Act (NEPA) requires assessment of impacts of proposed actions; implemented by Department of the Army 32 Code of Federal Regulations Part 651 Environmental Analysis of Army Actions; Final Rule. Noise is often one of the primary issues. A highly ranked Army Environmental Quality Technology (EQT) Research and Development (R&D) Requirement, *Training and Testing Range Noise Control*, is a major requirement for this project. Another highly ranked Army EQT Requirement, *Impact Protocols for Military Operations on Threatened and Endangered Species (T&ES)*, identifies noise as one of three impacts of particular concern. Regulatory drivers include the Endangered Species Act of 1973, as amended, the NEPA of 1970, as amended, the Sikes Act of 1995, and the Marine Mammal Protection Act. The software complies with applicable noise assessment practice promulgated by the American Nation Standards Institute (ANSI).

SARNAM™ is optimally used as an environmental planning tool to address unwanted noise as an environmental attribute in the community at large, rather than as a regulatory compliance tool, since there are no legally binding criteria for human exposure to noise that support “compliance” levels outside the facility perimeter. Calculated noise contours are used as planning tools for land use guidelines. SARNAM™ can be used to avoid siting new noise sensitive land uses in off-post areas impacted by military noise, as well as to plan military facilities and operations to minimize community noise levels.

1.4 Stakeholder/End-user Issues

The primary end-user is the USACHPPM Operational Noise Program; the group that provides blast noise consultation to all of DoD for both large and small arms. Other users include private sector consultants and installation personnel who perform noise assessments for installations. All of them are concerned about software accuracy, implementation cost, cost savings, and ease of use. The Army developed the SARNAM™ software in house, so there are no proprietary considerations. Implementation cost consists essentially of learning to use the software, which is facilitated by familiarity with acoustics and military weapons systems. SARNAM™ cost savings enable USACHPPM to provide faster and more accurate cost-effective noise control consultation to a larger number of DoD installations to protect and facilitate combat training mission capability.

Within the Department of Defense, each Service has lead responsibility for certain types of noise management technology; this arrangement was recently formally affirmed under the auspices of the DoD Noise Working Group established by DoD Instruction 4715.13 (DoD 2005). Under this mutual reliance arrangement, the Army is responsible for blast noise (large and small caliber) technology for all of the Services, including supersonic projectile sonic boom noise, muzzle blast noise, and projectile, warhead, and explosive detonation noise. This responsibility is satisfied by the cooperative efforts of two Army organizations. The ERDC/CERL carries out research, development, and transfer of technology and tools needed to assess, mitigate, and manage military-unique noise impacts. The Operational Noise Program of the USACHPPM is the primary training and testing noise management consultant to the U.S. military for helicopter,

small arms, and blast noise, and is motivated to ensure that the noise software applications are accurate and useful, since they will rely on the software to carry out mission functions.

Installations rely on noise impact assessment software to guide decisions. One installation user provided the following written comment. "...growth of population in adjacent areas has increased the numbers of noise complaints. The predictive noise models that have been developed at CERL and at USACHPPM have been exceptionally valuable in preparation of NEPA documentation through the years. In fact, these models have been the most useful and most frequently applied of all models. And, in a real way, these models have probably prevented more adverse publicity and controversy than any other environmental impact model (predictive tool) I have ever used here."

2. Technology Description

2.1 Technology Development and Application

The SARNAM™ software application provides the capability to calculate and display noise level contours for small arms range firing operations involving military and commercial weapons up to and including the .50 caliber machine gun. All of the DoD Services rely on SARNAM™ to model small arms blast noise, and the software is also useful at law enforcement and recreational shooting ranges. The software is designed to enable installations to carry out some noise management tasks and calculations themselves. Since specialized expertise is required to execute some aspects of blast noise assessment, installations can take advantage of USACHPPM expertise and experience to complete complex or critical noise studies for purposes such as ONMP and NEPA.

The architecture of SARNAM™ is shown in Figure 1. The software consists of three program modules: the GUI (graphical user interface), the DOCALC calculation engine, and the noise map plot (NMPlot) contour display application. The information that the user enters via the GUI is written to a case file and handed to the calculation engine. The data calculated by the engine is written to the NMBGF file and handed to NMPlot for fitting and display of noise contours. SARNAM™ features a point-and-click graphic user interface, pull-down menus, and online help, all designed to maximize user productivity (Pater et al. 1999). SARNAM™ runs under the Windows™ operating system.

Received sound level depends greatly on atmospheric propagation conditions (Schomer and Luz 1978). Sound propagation velocity in the atmosphere is determined primarily by temperature and wind velocity (speed and direction), with second-order dependence on relative humidity and barometric pressure. These parameters vary with time and with height above the ground, particularly near the earth in what is termed the boundary layer and at higher altitudes at an inversion layer. The resultant variation of sound propagation velocity with altitude causes sound to refract in much the same way as a lens refracts light. Experience during this and previous investigations has provided information regarding the degree of variation in received sound level for small arms. With a calm clear day as reference, measurements have shown that even a moderate breeze can cause about a 5 dB increase downwind and a decrease of as much as 15 dB in the upwind direction (Pater 1992, Pater et al. 1994). Overcast versus sunny conditions have a large effect that results from solar radiation heating the ground surface and affecting the air

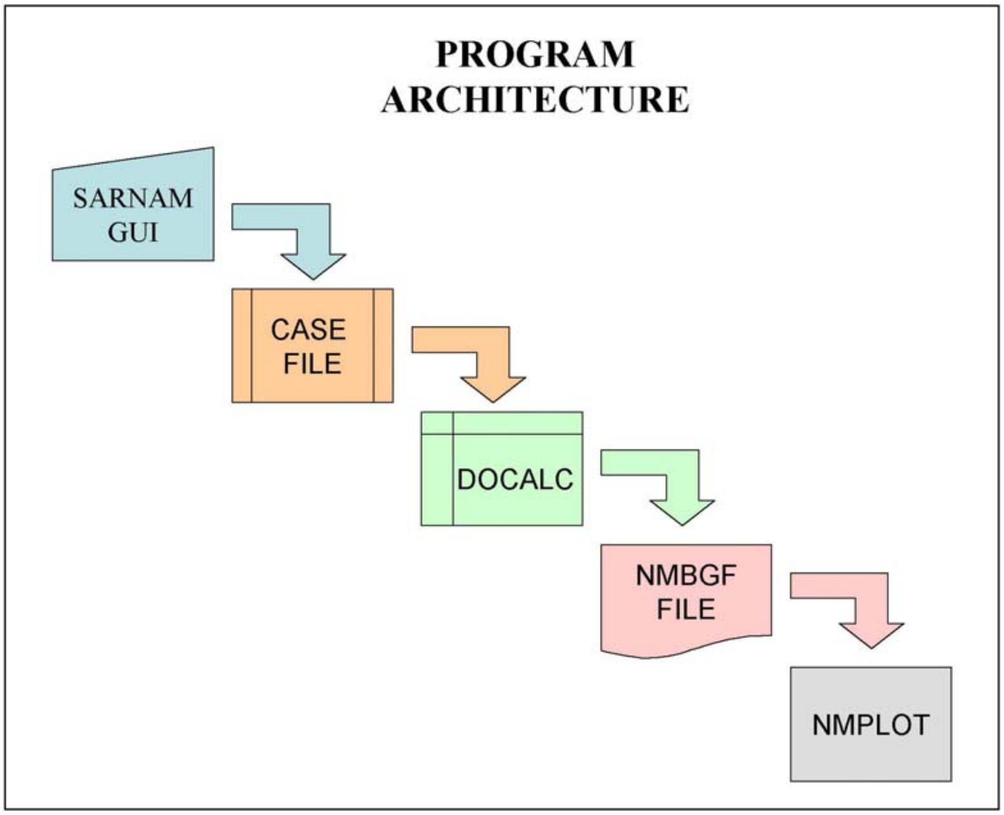


Figure 1. SARNAM™ Architecture and Process Diagram.

temperature near the ground. Prevailing weather conditions and ground cover will cause sound levels to generally be substantially louder in winter than in summer. The authors have also measured variations of as much as 30 dB during a time period of only a few minutes, probably due to atmospheric turbulence (Pater 1981). To put these variations into perspective, a 10 dB increase represents roughly a doubling in subjective loudness for many types of noise (Crocker 1998).

The calculation algorithms used in SARNAM™ were previously verified to be accurate under known propagation conditions, as described in paragraph 2.2 below. Budget reductions during SARNAM™ development prevented detailed accounting for the full range of weather effects. SARNAM™ sound level predictions were therefore based on a single weather case, chosen to yield a reasonable approximation to expected average propagation conditions. The SARNAM™ propagation algorithm predicts the mean expected value of noise level metrics for mild downwind conditions. This calculation is used in all directions, which moderately over-predicts noise levels in some regions, since the wind cannot be blowing in all directions at any one time.

To make a run, the user first creates an activity file that specifies the weapons, the locations at which they are fired, range attributes such as size and barriers, and the number of shots during daytime and nighttime. Options chosen from pick lists include the weapons, sound exposure metrics, frequency weightings, and assessment procedures that are appropriate for small arms

noise (Hede and Bullen 1982, Luz et al. 1983, O'Loughlin et al. 1986, Sorenson and Magnusson 1979). A sound source emission model for each weapon, based on experimental measurements and included in a source database within the software, is the starting point for propagation calculations. A propagation algorithm is used to calculate sound levels at each node of a user-defined geographical grid. The resulting grid array of noise level values is converted to contours and prepared for display by the NMPlot software developed by the U.S. Air Force. Both the propagation algorithm and the source models enable consideration of spectrum and directivity of muzzle blast (Pater 1981) and projectile bow shock, which facilitates accurate calculation of propagation attenuation and barrier insertion loss.

The main page of the SARNAM™ application is shown in **Figure** 2. From this page the user selects the various pages for data entry, and selects database files that will be used, for a noise impact assessment. This page is the control center from which the user directs and controls SARNAM™. **Figure** 3 shows one of the data entry pages, the activity page, on which the user enters the details of a training activity. **Figure** 4 shows typical noise contour results calculated by means of the SARNAM™ software. The Noise Zone Descriptions are defined in Appendix A.

A feature of SARNAM™ known as "OneShot" (note the button on the main page shown in **Figure** 2) enables a quick estimate of the expected statistical range of received noise levels at a given location for a particular weapon firing. The OneShot page within the software is shown in **Figure** 5. Typical OneShot results are shown in Figure 6.

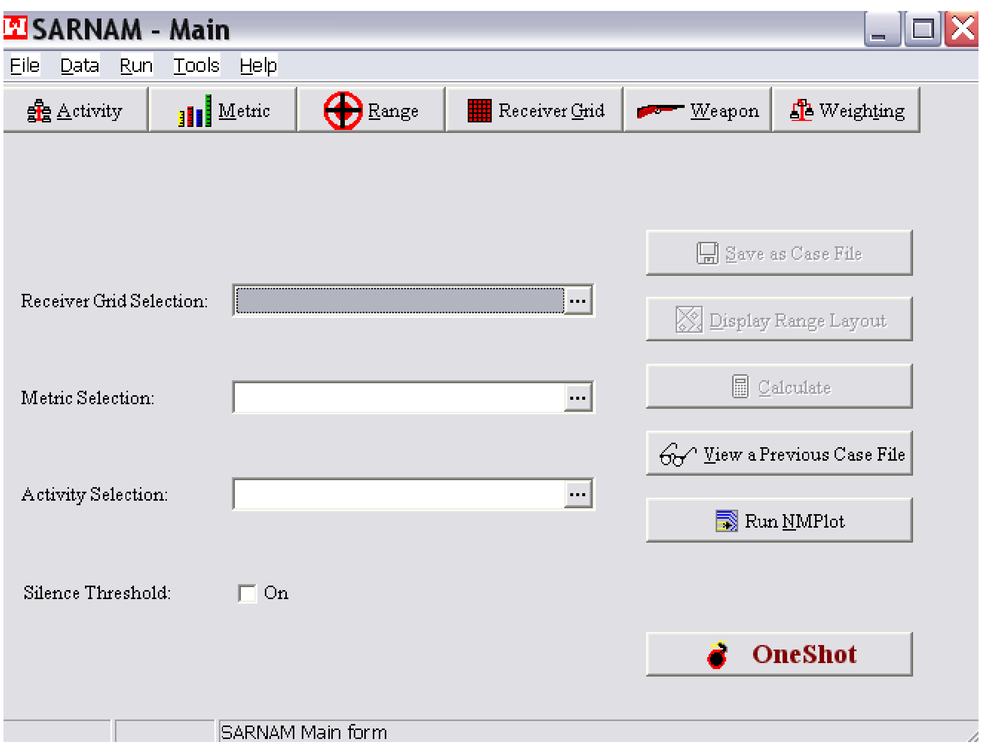


Figure 2. SARNAM™ main page.

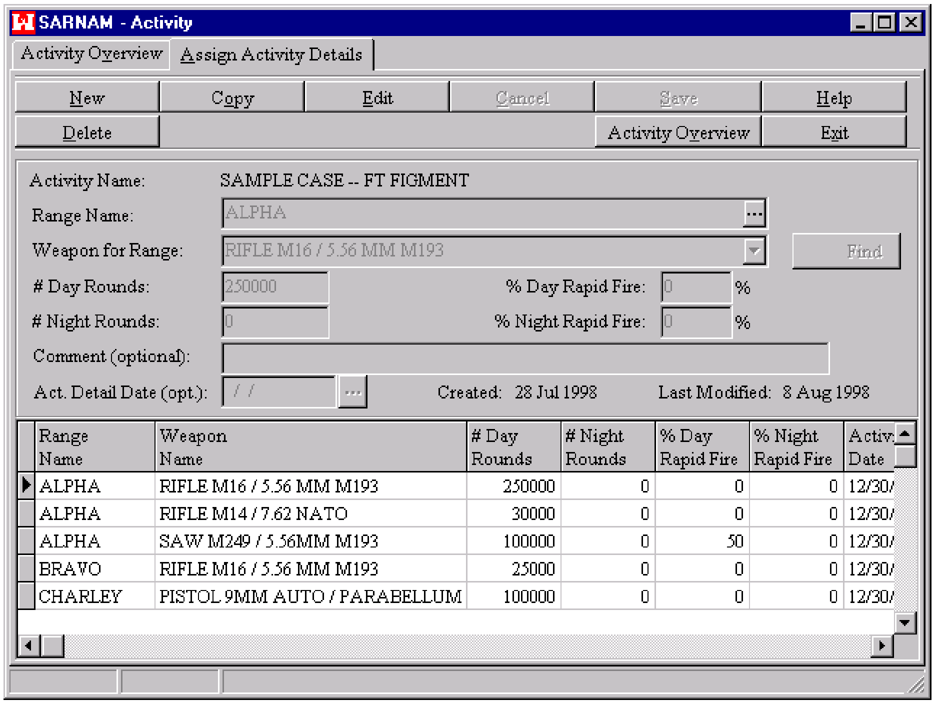


Figure 3. Sample SARNAM™ activity page, showing training activity details.

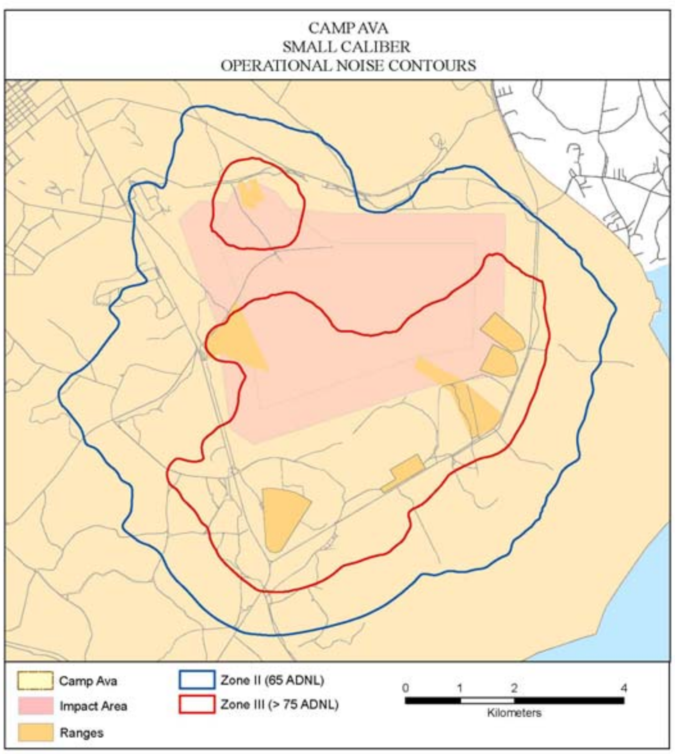


Figure 4. Typical noise contour output from SARNAM™.

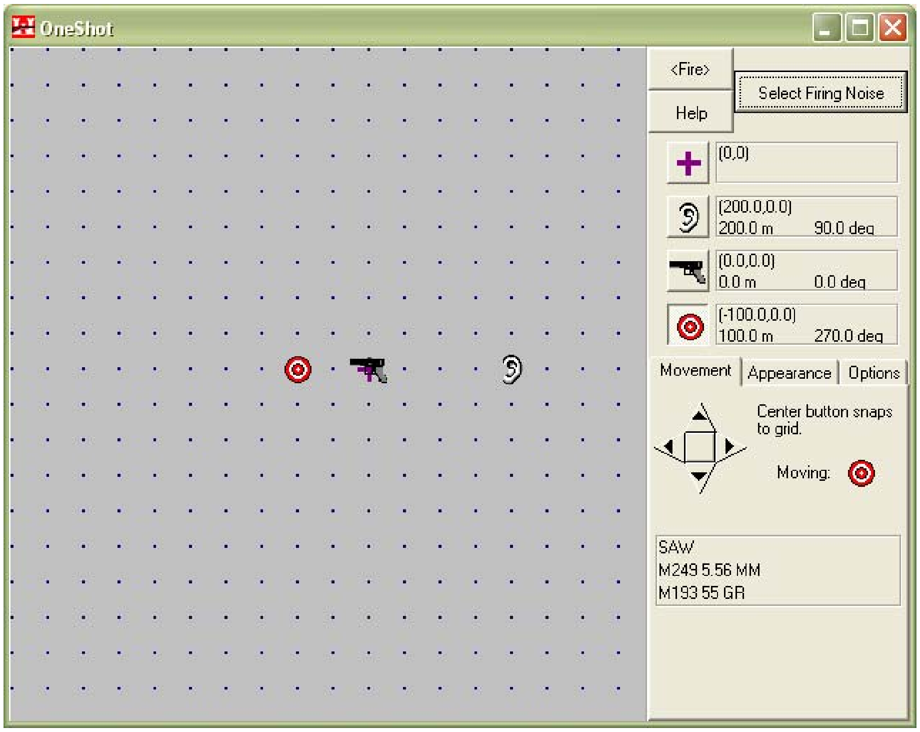
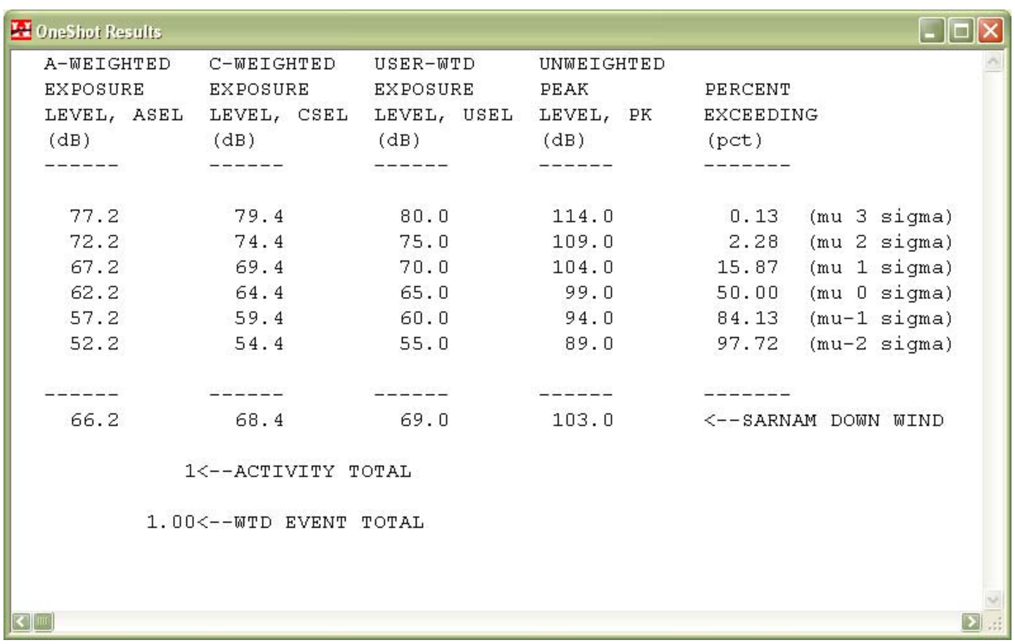


Figure 5. OneShot control page.



OneShot Results

A-WEIGHTED EXPOSURE LEVEL, ASEL (dB)	C-WEIGHTED EXPOSURE LEVEL, CSEL (dB)	USER-WTD EXPOSURE LEVEL, USEL (dB)	UNWEIGHTED PEAK LEVEL, PK (dB)	PERCENT EXCEEDING (pct)	
77.2	79.4	80.0	114.0	0.13	(mu 3 sigma)
72.2	74.4	75.0	109.0	2.28	(mu 2 sigma)
67.2	69.4	70.0	104.0	15.87	(mu 1 sigma)
62.2	64.4	65.0	99.0	50.00	(mu 0 sigma)
57.2	59.4	60.0	94.0	84.13	(mu-1 sigma)
52.2	54.4	55.0	89.0	97.72	(mu-2 sigma)
66.2	68.4	69.0	103.0	<--SARNAM DOWN WIND	

1<--ACTIVITY TOTAL

1.00<--WTD EVENT TOTAL

Figure 6. OneShot results: range of expected noise levels for a particular firing scenario.

2.2 Previous Testing of the Technology

Considerable testing of the software elements occurred before this current validation and demonstration project. The assessment procedures, metrics, and frequency weightings follow American National Standards Institute (ANSI) standards (ANSI S1.1 2004, ANSI S1.4 2001, ANSI S12.9 Pt.1 2003, ANSI S12.9 Pt. 4 2005). The software uses, as the starting point for noise level predictions, an acoustical emission (source) model that is based on careful measurements for each weapon (Pater 1981, and unpublished data). The propagation algorithms that are used to predict noise levels (Gilbert and White 1989, White and Gilbert 1989, Li et al. 1994, White and Li 1996) were verified by comparison with experimental data under known atmospheric propagation conditions (White 1994). SARNAM ™ small arms sound level predictions have been compared with single event measurements with good agreement (unpublished data). CHPPM began to use the beta version of the software immediately to deal with a backlog of small arms consultations, and so had considerable experience in using it before this current project. The current project was designed to test SARNAM™ under realistic, uncontrolled conditions that are encountered in typical noise management efforts at installations.

2.3 Factors Affecting Cost and Performance

The software runs on common personal computers under the Windows™[1] operating system. The demonstration/validation project used commercially available noise monitoring equipment. The Army developed the SARNAM™ software in-house and so there are no proprietary or purchase cost considerations. The cost of using SARNAM™ is largely collecting and verifying training activity input data, entering the data, and analyzing and organizing results to guide decisions.

2.4 Advantages and Limitations of the Technology

SARNAM™ is the only software available in the United States for assessment of small arms range noise. Before this software, small arms noise analysis consisted of expensive on-site measurement that sampled only a limited time period, supplemented by hand-calculated estimates whose quality depended on the consultant's knowledge of an esoteric field. The capability to quickly produce noise contours and to evaluate alternative noise mitigation strategies offers many benefits. SARNAM™ is highly useful as effective support of an environmental planning process as required by DA PAM 200-1 (2002). Given the always-present uncertainties in propagation conditions and operation parameters (e.g., weapon, location, number of shots) that strongly influence sound level predictions, good agreement between predictions and spot measurements is not a reasonable expectation. Accuracy of predicted sound level ultimately depends not only on accurate source models and propagation algorithms, but also on accurate knowledge of the current sound speed profile in the atmosphere, the type and location of weapon, and the number of shots. The critical result of the SARNAM™ technology is that the community noise impact will be less severe than it would have been without the technology. The software is most effective for reliable determination of the effects of changes in operations or facility location and design, which provides extremely useful noise impact management guidance regardless of momentary uncertainties.

[1] Citing product or company names does not constitute endorsement by ERDC/CERL, USACHPPM, ESTCP, SERDP, or the U.S. Army.

3. Validation and Demonstration Design

3.1 Performance Objectives

The overall goal of this project was to demonstrate and validate the SARNAM™ small arms noise impact assessment software. The objective of the "validation" aspect of this project was to test the accuracy of SARNAM™ by comparing calculation results with comprehensive noise monitor data to judge noise level prediction accuracy. The objective of the "demonstration" aspect of the project was to evaluate the software utility and cost during realistic noise management consultation.

Validation of the software consisted of measuring noise levels in training scenarios over an extended period of time, and then comparing the measured results with the calculated results from the software, the obvious criterion being the degree of agreement. This was planned to be accomplished by measuring and recording noise levels at several locations and distances during normal training operations for an entire year, to sample a wide range of weather conditions.

The primary performance measures of the demonstration aspect of the project are reduction in community noise exposure and cost. This was determined by USACHPPM and installation personnel by first using the noise software under consideration to assess noise exposure for a new proposed range. The software was then used to explore community noise dose reduction options. Factors of importance include ease of use and cost performance.

Quantifiable performance objectives, as originally stated for this project, are as follows:

1. Agreement between predicted and measured noise levels within 5 dB;
2. Enable a 20 % reduction in community noise exposure in siting training activities;
3. Enable a 20% reduction in overall cost associated with noise impact assessment.

The goal of enabling a 20% reduction in community noise exposure bears further explanation and consideration. A reduction of 20% in sound exposure (SE) is a reduction in sound exposure level (SEL) of only 1 dB, while a 50 % reduction in SE is a reduction of about 3 dB in SEL. An SEL reduction of 10 dB is required to achieve a 50% reduction in <u>perceived</u> noise level (Crocker 1998), which implies that a 20% reduction in subjective noise exposure requires an SEL reduction of about 3 dB. While a 3 dB reduction in noise level can be useful, a 4 or 5 dB reduction in SEL or day-night level (DNL) is a traditional goal for a noise level reduction that is unarguably significant in terms of human perception of noise exposure. A typical noise mitigation goal of the Army Noise Program, under the Environmental Quality Technology Program goals, is 5 dB. This more stringent noise reduction goal was adopted as the goal for judging SARNAM™ performance in this ESTCP demonstration project.

3.2 Selecting Test Sites/Facilities

The primary selection criteria for the validation site were: sufficient firing activity, terrain suitable for carrying out noise measurements, and availability of adequate training records to guide noise model calculations. Site personnel must be willing to support and assist the project and provide contributions that leverage with ESTCP, CERL and USACHPPM resources. The SARNAM™ software was validated at the Marseilles Training Area, a facility of the Illinois Army National Guard (IL ARNG), which was judged to meet all of the criteria.

The Marseilles Training Area, while ideal for validation, has minimal community noise problems. Another site was therefore chosen as the demonstration site to provide a useful example of how SARNAM™ can be used to reduce noise impact. This site is a major military training facility that will be referred to by the pseudonym "Camp Ava" to comply with installation directives regarding facility and operational security. This demonstration example is an actual noise mitigation consultation that was carried out by USACHPPM, and is presented in a way that illustrates the use and advantages of SARNAM™.

3.3 Test Site Characteristics and History

SARNAM™ field validation was carried out at the Marseilles Training Area, an IL ARNG facility located in LaSalle County in north-central Illinois. The closest town is Marseilles, which is four miles distant. The pollution emission of concern, small arms noise, is generated by training exercises of the ARNG and local law enforcement entities. It is the primary training area for the IL ARNG. The Marseilles Training Area is a typical ARNG small arms facility. It encompasses 2552 acres, about four square miles, and features four small arms ranges of various types located in the southeast portion of the installation. The terrain is generally rolling and wooded, but is relatively flat and open in the vicinity of the ranges, which facilitates noise measurement. The noise monitor sites were on ARNG property or on adjacent private property. A map of the entire Marseilles Training Area is shown in Figure 7. The small arms ranges are arrayed in the southeastern portion of the installation, with headquarters and the cantonment area located in the southwestern corner. The ranges are outlined in red in Figure 7, and the range complex surface danger zone is shown outlined in black. A similar map in Figure 8 highlights the small arms range complex more clearly. A more detailed map of the southern portion of the installation, shown in Figure 9, shows the small arms ranges and the noise monitor site locations. Figure 10 shows a photo of one of the small arms ranges at the Marseilles Training Area, featuring a covered firing line and earth safety berms at the sides of the range and behind the targets. Figure 11 shows a view looking downrange on a 300-meter target range, which gives a general impression of the area; this range is a known-distance range that has targets located at several distances from the firing line. Figure 12 shows a general view, from a public highway adjacent to the installation boundary, of the range complex in which may be seen the covered range, berms, and a range control tower. A typical noise monitor site and instrumentation are illustrated in Figure 13 and Figure 14.

The SARNAM™ software application was demonstrated as part of a range planning and siting study for a Multi-Purpose Machine Gun (MPMG) .50 Caliber Range at "Camp Ava." Specific distinguishing features of the installation and surrounding population distribution, particularly details of range location and function, have been modified at the installation's request in the interest of facility and operational security. The features shown in Figure 15 are faithful to the situation for purposes of demonstrating the use of SARNAM™ to achieve noise reduction. The facility is typical of many large installations in that it has been a major training facility for over 50 years. It was initially located in a sparsely populated region, but communities grew up nearby to serve the needs of the installation; as they grew, they became less economically dependent on the installation, and increasing awareness of environmental quality led to a population less tolerant of the noise that is implicit in the operation of a combat training facility.

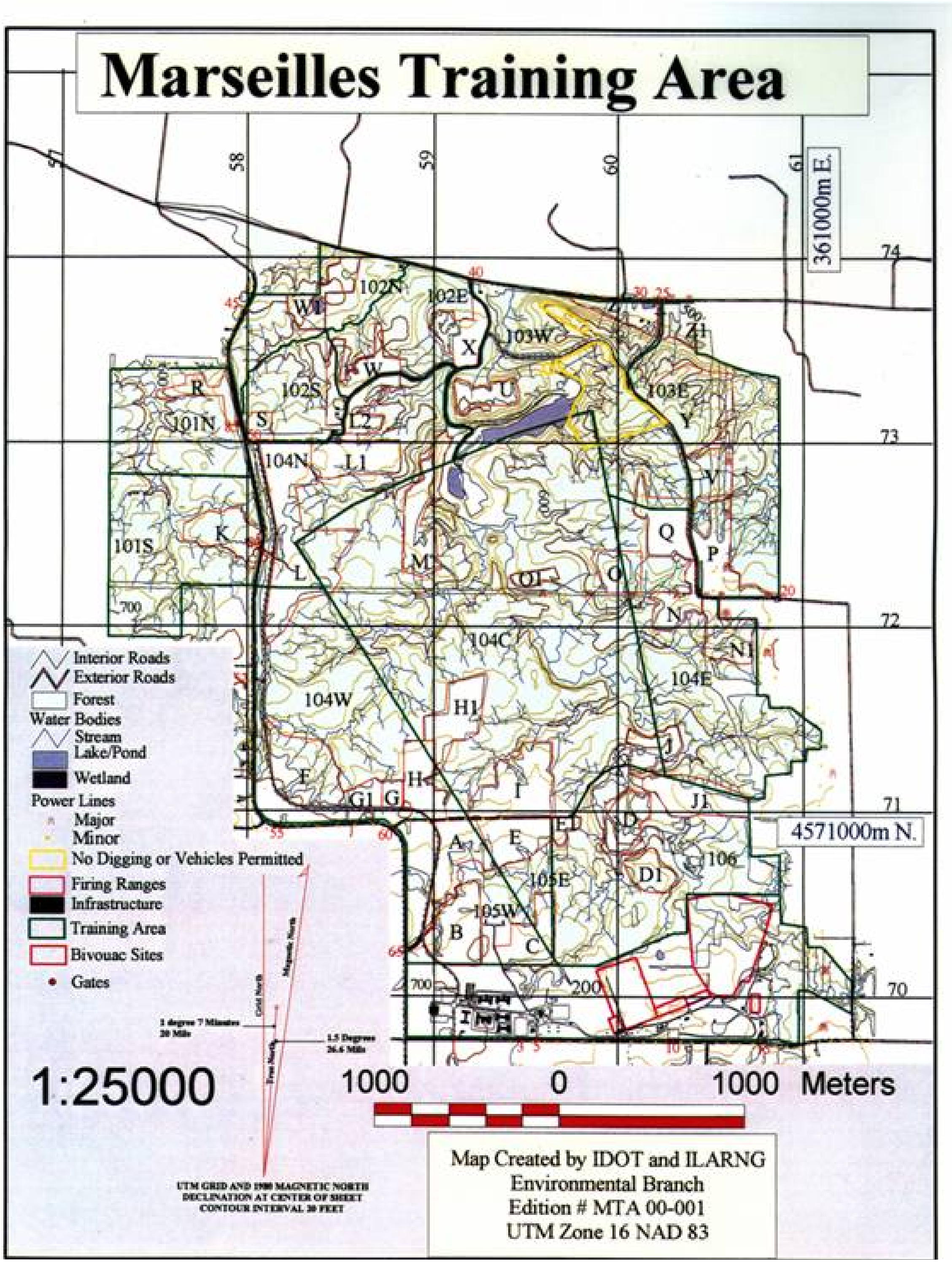


Figure 7. Illinois Army National Guard (ARNG) Marseilles Training Site map.

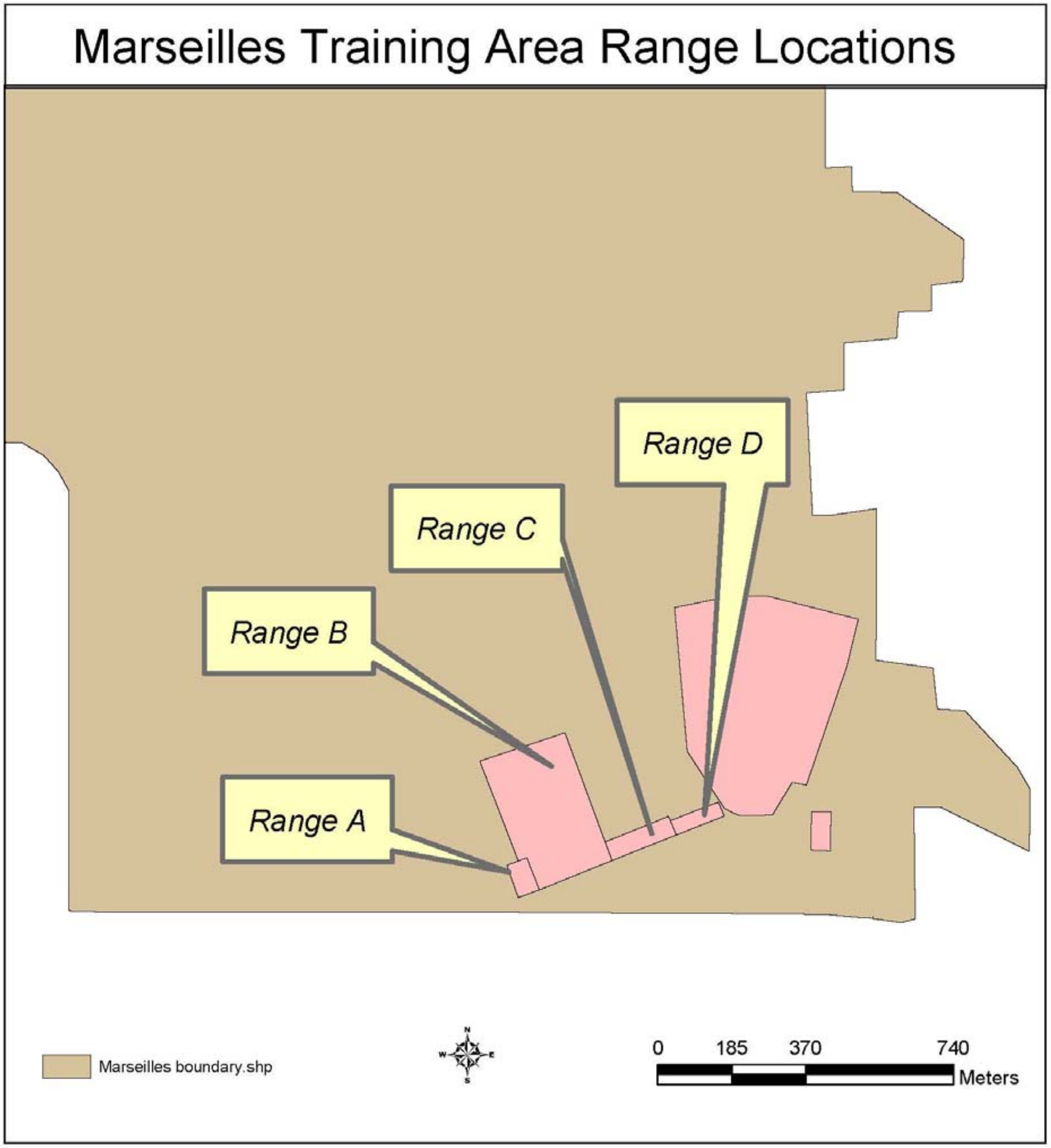


Figure 8. Location of small arms ranges on Illinois ARNG Marseilles Training Site.

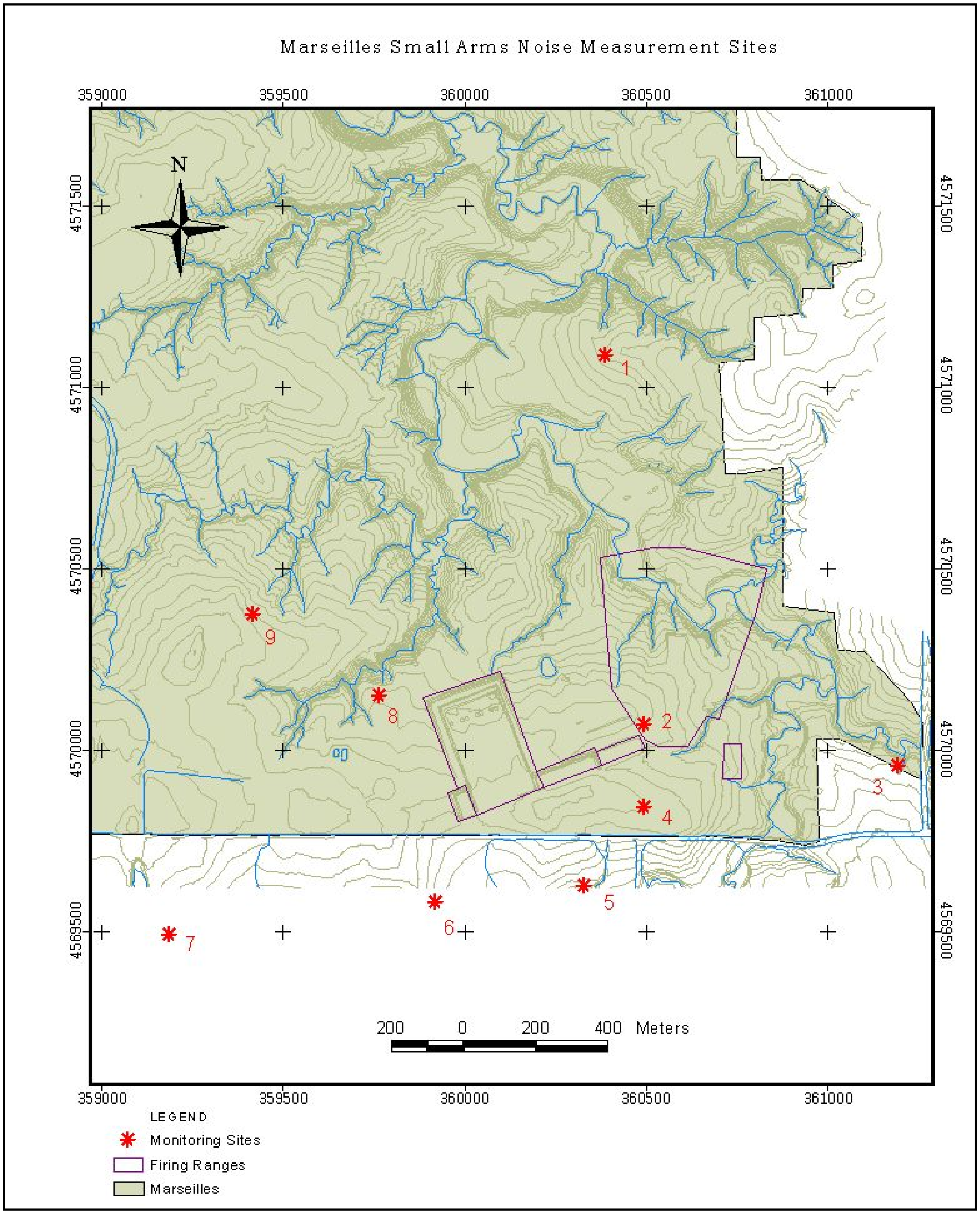


Figure 9. Ranges and noise monitoring sites at Illinois ARNG Marseilles Training Site.

Figure 10. Photo of a small arms range at Marseilles Training Area featuring a covered firing line and safety berms at the sides of the range and behind the targets.

Figure 11. View downrange on a 300 m known distance target range at the Marseilles Training Area. This view gives a general impression of a typical range.

Figure 12. A general view of the Marseilles Training Site small arms range complex and proximity to private lands (right side of picture).

Figure 13. Installing a noise monitor. The battery box is the large lower box while the recording instrumentation is contained in the upper box.

Figure 14. Typical noise monitoring site.

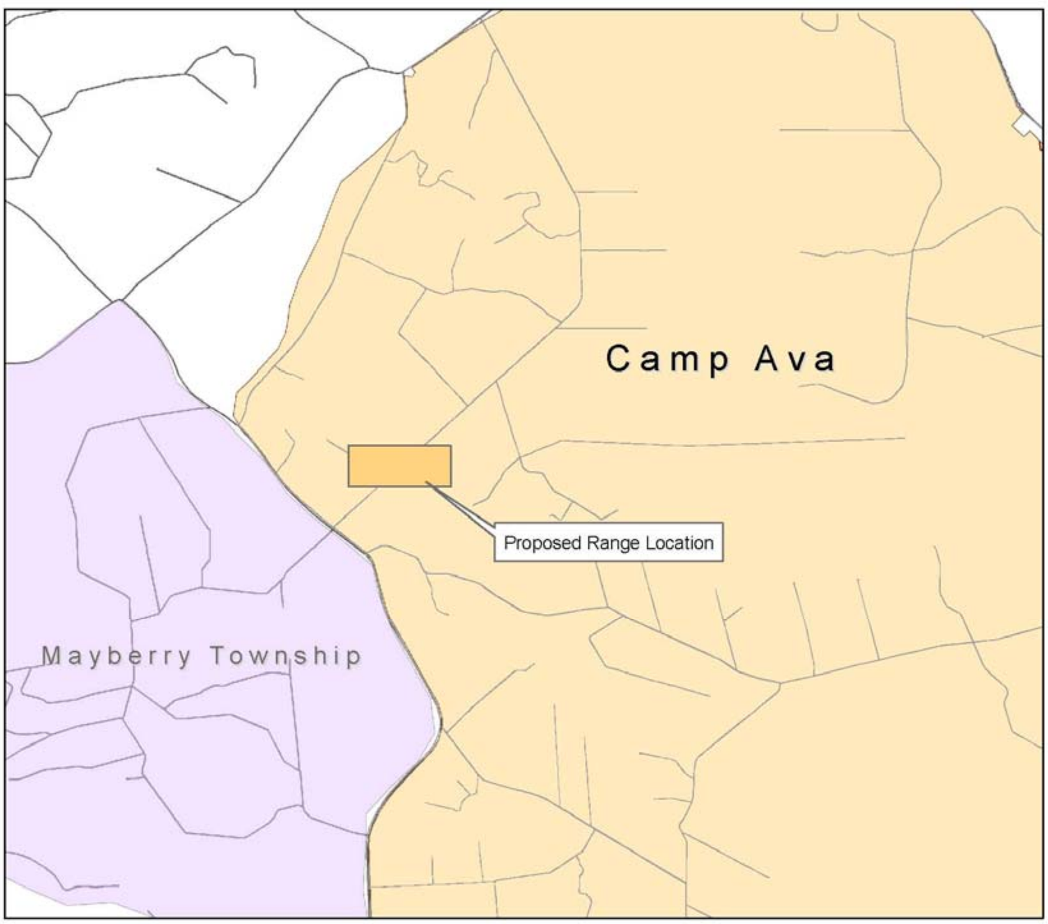


Figure 15. Proposed Firing Range Location on "Camp Ava."

3.4 Present Operations

Both sites are active military installations that carry out a wide variety of essential training. The firing activity at Marseilles Training Site during the validation period consisted of training exercises by the ARNG and local law enforcement entities; weapons fired included military and civilian rifles, pistols, shotguns, and automatic weapons up to 7.62 mm. The firing activity of interest at Camp Ava was .50 caliber machine gun training.

3.5 Preliminary Testing and Analysis

In preparation for the validation effort, the Marseilles Training Site was visited several times to discuss the project with site personnel and to secure their cooperation with and commitment to the project. Nine noise monitor sites were selected, located on the installation and on nearby private land. Maps, on-site surveys, information regarding weapons used at the site, and SARNAM ™ calculations were used to select the monitoring sites shown in Figure 9. The noise monitors were located at sites chosen to sample noise levels at a selected variety of distances and directions relative to the small arms ranges, taking into account directivity of both muzzle blast and projectile sonic boom noise. The measurement site locations were dictated to some extent by terrain characteristics and by year-round accessibility. Ambient noise level measurements were preformed to guide monitoring site selection and noise monitor setup.

Preparation for the demonstration portion of the project consisted of discussions with installation personnel regarding anticipated firing schedules and estimated number of shots to be fired during a typical year. Data was gathered regarding population distribution in the environs of the installation, and terrain features that might limit range location were discussed.

3.6 Testing and Evaluation Plan at the Validation Site

3.6.1 Validation Set-Up and Start-Up

The SARNAM™ noise model, the technology of interest in this project, was ready for demonstration and validation by Fiscal Year (FY) 02 after beta testing by USACHPPM in FY01. For validation purposes, the principal data to be sampled were noise levels during training operations. The primary sampling equipment consisted of noise monitor units, encased in weatherproof containers as shown in Figures 13 and 14, and powered by storage batteries, that were installed at the locations shown in Figure 9. Before use, the noise monitors were programmed to measure the desired metrics according to menu selections. Monitoring technology startup required that the monitor units be integrated into a system that includes batteries to power the equipment in untended mode for at least two weeks and protective boxes to deter theft and weather damage. Initiation of data collection required that the equipment be installed in the field, which entailed transporting the equipment to the measurement sites, setting it in place, and performing calibration.

3.6.2 Period of Operation of Validation

Noise level sampling activity for SARNAM™ validation was planned to occur during an entire year of firing at the installation, to encounter the full range of propagation conditions and training activities on a diurnal and seasonal basis. However, for a variety of reasons, primarily the terrorist attack that has come to be known as “9/11,” firing was

discontinued late in the fall and not resumed until late spring. The actual sampling period was from May 23 through Oct. 30, 2001.

3.6.3 Amount / Treatment Rate of Material Treated

Sound levels were measured at several locations continuously throughout the sampling period. Firing of small arms for training purposes occurs intermittently, and in varying amounts, as dictated by training schedules that depend on many factors. Firing records indicated that a total of over 300,000 shots were fired during the sampling period. Details of the number and timing of noise events used in the validation process are discussed later in this report.

3.6.4 Residuals Handling

The impact associated with weapons firing is primarily annoyance, which can lead to actions by community residents to attempt to curtail the firing activity. In some comparatively rare cases, impacts can also consist of structural damage, usually window breakage. Claims of more extensive damage are normally unfounded. There is no residual process waste associated with weapons noise impact on the community or with the use of noise monitors or software. The sound energy is converted to a tiny amount of heat by dissipation in the atmosphere. There is no hazardous residual. The only hazard likely to be encountered during this project was potentially excessive noise levels that might cause hearing damage. This was avoided by the wearing of hearing protectors whenever project personnel were exposed to potentially hazardous noise levels. Only one or two people were required to operate the technology. Workers had to be able to work outdoors and be able to lift weights of less than fifty pounds. Some equipment breakdowns occurred, but did not constitute a hazard to workers. The equipment had no significant impact on the surrounding environment.

3.6.5 Operating Parameters for the Technology

The normal operation parameters of the SARNAM™ noise model technology consists of calculating noise contours based on information regarding type of weapons and number of rounds fired on firing ranges of known location and construction. The accuracy of the noise contours is of interest and depends on the validity of this input information and on the accuracy of the model calculations.

3.6.6 Experimental Design

Impulsive noise from typical weapons training operations is the contaminant that this technology mitigates. Noise is an implicit byproduct of military weapons training that cannot be eliminated; indeed, blast noise emission has generally increased with each increase in weapons performance. Received noise level is strongly influenced by weather. Random sampling is not adequate; every significant noise event must be measured and recorded to achieve success in this project because of the random effect of weather on received noise level, as discussed in detail later. Further, it was necessary that spurious noise events, such as bird songs, car door slams, farm equipment, and weather events such as thunderstorms and strong winds, be excluded as false data.

CERL, the software developer, carried out the noise measurements, with assistance from installation personnel. USACHPPM, the primary user of the software, judged the validity of the noise software predictions by comparing them with the experimental data, and provided QA/QC, including oversight of the experimental data collection and analysis.

Sound levels resulting from training operations were sampled by means of Norsonics™ Model 121 noise monitors. These commercial off-the-shelf noise monitors were represented to be capable of untended operation over extended time periods and also capable of simultaneously and accurately measuring values of several appropriate blast noise metrics, particularly sound exposure level and peak (Hede and Bullen 1982, Luz et al. 1983, O'Loughlin et al. 1986, Sorenson and Magnusson 1979, CHABA 1981, CHABA 1996). These monitors use microprocessors that can be programmed to measure desired noise metrics of any noise event that exceeds a user-selected threshold, which after an initial period of trial and error was set at 85 dB A-weighted-peak sound pressure level (SPL). This trigger level avoided a large number of false events, particularly signals generated by wind flowing over the noise monitor microphone, which would quickly fill up data storage space, and also avoided data contaminated by wind noise. Thus many low-level firing events were very probably not recorded. Experience has shown that the threshold for receiving complaints about small arms noise is in the vicinity of 85 dB, so the most important events were captured. An important feature of the monitors was the capability to make an audio recording of each noise event, which enabled post-process verification of the type of noise event measured. Data "download" was accomplished by changing out 1 GB microdrives. A total of ten noise monitors were used. Nine were used at monitoring sites, with one held in reserve as a spare in case of equipment malfunction or breakdown. Performance audits and on-site system audits consisted of checking the equipment during each visit to ensure that it was operating properly, checking system calibrations, and checking that the data had been recorded. Each site was visited approximately once every two weeks (more often at the beginning) throughout the year of monitoring at the validation site. A written logbook was maintained of all inspection, maintenance, battery replacement, calibrations, and microdrive exchanges. These records contain, as a minimum, the dates of the operations and whether the maintenance operations were routine and followed standard operating procedures. Written records were kept of non-routine repairs performed on equipment as a result of failure or malfunction and documented the nature of the defect, how and when the defect was discovered, and any remedial action taken in response to the defect.

The noise metrics monitored and the data format were specified during the setup programming of the Norsonics™ noise monitors. The quantities that were measured for each noise event include unweighted octave band sound exposure level (SEL), overall (broad band) event SEL with A- and C- frequency weighting, peak, and the date and time of each event. A pre-trigger function ensured that the entire event was captured. The audio recording was used to determine if the measured event was in fact a small arms firing event by listening to the audio clip of each event as recorded by at least one monitor. These measurements enable characterization of gun shot noise events in terms of both single event and long-term average noise metrics. Ambient background levels

were also measured as hourly equivalent sound level (LEQ) levels with A-weighting. Data verification was via appropriate calibration procedures as specified by the monitor manufacturer, which meet ANSI sound level meter standards (S1.4 2001). A written log was kept of monitor site visits for purposes of data download, calibration, equipment checkout, and battery replacement.

The known general characteristics of how the sound level varies in the field around the gun guided sampling protocols, particularly choice of the sampling sites. Sound energy emitted by a point source, such as the gun muzzle blast or projectile detonation, travels outward from the source on a spherical wave front. The gun muzzle blast is a strongly directive source that typically exhibits about 10 to 15 dB variation in source strength with azimuth (Pater 1981). The sonic boom noise from supersonic projectiles exhibits additional directivity; it in fact exists only in a region downrange of the firing point, typically within an arc of about sixty degrees on either side of the line of fire. Sonic boom noise spreads conically rather than spherically. All of these issues influence the optimum location for noise level sampling. Detailed locations of the measurement sites shown in Figure 9, as well as range features, are presented in Tables 1 and 2. Locations are given as Universal Transverse Mercator (UTM) coordinates measured by hand-held Global Positioning System instruments.

The effect of weather on sound propagation yields large variations in received sound level. Weather can cause a variation in received noise level of 20 dB even at relatively near distances, and as much as 50 dB at a given receiver location at larger distances (Schomer and Luz 1978). This is a huge change in noise level; an increase of about 10 dB in many types of noise (Crocker 1998) is subjectively twice as loud! The increase is sharper for blast noise, with doubling of apparent loudness for every 5 to 7 dB increase in blast noise level (Luz, pers. comm.). The effect of weather on noise propagation exhibits a strong circadian pattern (generally enhanced propagation at night, with rapid transitions around dawn and dusk) and a strong annual pattern (generally enhanced propagation in the winter months compared with summer), but also varies widely from day to day. The monitoring locations were selected to maximally sample the range of these variations at locations of greatest interest for assessing community noise impact. Because SARNAM™ is intended to assess noise dose in the past or future when weather cannot normally be known with sufficient accuracy, and because of the prohibitive costs of meteorological data collection, there was no detailed meteorological data collection or correlation with noise monitoring. The sampling plan was developed to use the entire range of the program capability, including muzzle blast noise and supersonic projectile noise (there is no projectile detonation noise for small arms). Random selection of sampling sites would be a less useful and less efficient procedure.

This project utilized noise events that occurred during actual training, consisting of hundreds of thousands of shots fired by the IL ARNG and law enforcement units. The sampling protocol was straightforward; the intent was to monitor noise levels continuously, so that all typical training noise events were measured. At approximately two-week intervals, the data were downloaded, the storage batteries were replaced, and the equipment checked and re-calibrated as needed. Not every event was actually

measured at every monitoring location because of equipment malfunctions and because many events were below the 85 dB trigger level. There was no experimental control over the firing events; to do so would be prohibitively expensive, and would lose the reality of actual training. Hundreds of thousands of noise events were fired by the IL ARNG and law enforcement units and measured by the noise monitoring equipment.

3.6.7 Demobilization

Demobilization consisted simply of removing the noise monitor units from the field. No site restoration or decontamination was required. There is no demobilization cost associated with the validation sampling, nor is there any such cost associated with operational use of the noise software.

3.7 Selection of Analytical/Testing Methods

The standard for monitoring, characterizing, and/or confirming technology performance is comparison of measured noise data with the software-calculated values. The assessment procedures were in accordance with the applicable ANSI standard (S12.9 Pt.4 - 2005) in effect at the time for annual average DNL (day-night level) noise impact assessment. Comparisons were also made of several sound level metrics, including single event metrics, on each day for which noise data was available, in terms of peak sound pressure level, total sound exposure level, and mean event sound exposure level.

3.8. Selection of Analytical/Testing Laboratory

This project was jointly executed by the ERDC/CERL Acoustics Team and by the USACHPPM Operational Noise Program. The ERDC/CERL Acoustics Team developed the noise software applications that are the subject of this demonstration and validation project. The USACHPPM Operational Noise Program performed Quality Assurance and Quality Control (QA/QC) oversight of the data acquisition procedures and was the ultimate judge of the utility of the software. ERDC/CERL and USACHPPM jointly participated in the analysis of the voluminous data, and together they judged the validity of the noise software based on comparisons between software predictions and field data. USACHPPM used the software in the demonstration portion of the project to judge utility, effectiveness, and cost for managing and mitigation training noise emission, based on their experience in providing operational noise consultation to DoD for over 30 years.

Table 1. Experimental layout.

MEASUREMENT SITE LOCATIONS (UTM)			
Easting	Northing	Site No.	
360390	4571090	1	
360497	4570072	2	
361200	4569960	3	
360498	4569846	4	
360334	4569627	5	
359922	4569581	6	
359186	4569492	7	
359768	4570152	8	
359420	4570375	9	
RANGE FEATURE LOCATIONS (UTM)			
Easting	Northing	Range	Remarks
359992	4569821	A	left berm SW corner
359967	4569885	A	berms NW corner
360008	4569899	A	berms NE corner
360034	4569836	A	berm SE corner
359921	4570129	B	berms NW corner
360093	4570191	B	berms NE corner
360202	4569896	B	berm SE corner
360206	4569898	C	left berm SW corner
360192	4569933	C	berms NW corner
360358	4569990	C	berms NE corner
360373	4569951	C	berm SE corner
360335	4570053	D	west end of target berm
360466	4570094	D	east end of target berm
360007	4569823	A	FP#1
360054	4569841	B	FP#1
360188	4569892	B	FP#25
360214	4569902	C	FP#1
360367	4569956	C	FP#55.
360382	4569966	D	FP#1
360486	4570006	D	FP#15

Table 2. Range Features.

Range A.
8 firing points. Lane spacing 3 m. Targets at 50 m. DOF 339 degrees.
Firing shed, over firing line, no walls, roof 28 ft front to back, 20 ft high front, 12 ft high rear.
Ignore the firing shed; no structure effect that SARNAM accounts for.
Side berms and target backstop berm intersect. Model right berm as left berm of Range B.
Side berms 4 m high, target berm 6 m high.
Range B.
25 lanes, lane spacing 6 m (19.5 ft). 300 m range. DOF 339 degrees.
Uprange portion of left berm same as right berm of Range A. Side and backstop berm intersect.
Side berms 4 m high, target berm 6 m high. Firing points are foxholes.
Range C.
55 firing points, foxholes, lane spacing 3 m (10 ft). Target distance 25 m. DOF 339 degrees.
4 m berms on both sides and behind targets. Left berm in common with Bravo range.
Range D.
Pistol range, 15 firing points, lane spacing 8 m. DOF 339 degrees. Target distance 25 m.
Target berm 2 m high. Left berm is Range C right berm. No right berm.
Range E.
Grenade range. No live fire. Targets at various distances up to 300 m.

4. Performance Assessment

4.1 Performance Criteria

4.1.1 Performance Criteria for Validation at Marseilles Training Site

The primary validation criterion that was specified in the demonstration plan before the project was initiated was agreement between measured levels and calculated results within 5 dB.

4.1.2 Performance Criteria for Demonstration at Camp Ava

The primary performance measures of the demonstration aspect of the project were specified to be a cost reduction of at least 20% and an achievable reduction in community noise exposure of at least 4 to 5 dB.

4.2 Performance Confirmation Methods

4.2.1 Performance Confirmation Methods for Validation at Marseilles Training Site

Validation of the SARNAM™ software consisted of measuring noise levels in training scenarios and comparing them with calculated results from the software, the obvious criterion being the degree of agreement. All aspects of the software had been individually tested, and the algorithms subjected to comparison with experimental data, by

ERDC/CERL during previous Research and Development (R&D) projects. This current project obtained data that tested the overall validity and accuracy of the SARNAM™ software under uncontrolled field conditions typical of installation operations. The principal data sampled was noise levels during training operations. Noise level sampling was performed during an entire year to encounter the full range of propagation conditions and training activities. Random sampling was deemed to be inadequate; every significant noise event (i.e., one that exceeds a threshold) was measured and recorded, to fully test how received sound level varies throughout the year. Further, it was necessary that spurious noise events be excluded as false data, as has been discussed earlier.

4.2.2 Performance Confirmation Methods for Demonstration at Camp Ava

The primary performance measure of the demonstration aspect of the project is reduction in community noise exposure. The SARNAM™ software was first used to assess community noise exposure for operations as usual. The software was then used to execute additional noise exposure assessments, exploring community noise dose reduction options. Other factors of importance include ease of use, accuracy, usefulness to plan training and testing, and cost performance. This analysis was performed by USACHPPM using an actual small arms noise assessment performed for Camp Ava and is presented in the next section.

4.3 Data Analysis, Interpretation and Evaluation

4.3.1 Data Analysis: Validation at Marseilles Training Site

4.3.1.1 Firing Records

The SARNAM™ calculated results that were compared with the experimental data were based on the range records provided by the installation, excluding days for which the records were obviously incorrect as discussed below. The critical parameters are the weapon type, location, and number of rounds fired. The type of weapon is important because weapons vary considerably in acoustical emission magnitude and directivity. The location is important because the distance to each monitoring site is different for each range (actually, for each firing lane of each range). The number of firing events that occurred directly affects SARNAM™ predictions of average noise level metrics such as DNL and LEQ. It was not economically feasible to be on site every day of the monitoring period to verify the range records, so they are an uncontrolled variable in this project. USACHPPM has found through experience that range records of doubtful validity are virtually always a factor in gunfire noise consultations.

Range Facilities Management Scheduling System (RFMSS) records of the training schedule, the reported date, weapons, range, and number of rounds, were obtained from Marseilles Training Site personnel. From these installation records and our monitoring data, the calendar of events and ammunition reports presented in Appendix C were compiled. The range records indicated that over 300,000 rounds were fired during the validation period, but close examination revealed discrepancies. There were days when the installation records indicated that firing had occurred, but the monitoring data did not detect any blast events, and also days when the records indicated no firing but shot noise events were recorded. In the interest of valid comparison, these data were not used in the

validation process. This clearly illustrates the uncertainty involved in obtaining accurate error-free firing records to use as input to the noise assessment software. The fact that the number of rounds heavily influences the value of long-term-average noise level metrics such as SEL, LEQ, and DNL, but not single event metrics such as peak and event SEL, is a persuasive argument for supplementing average metrics with single event metrics in noise impact assessment.

Another, more subtle, aspect of determining which data could be reliably used for comparison of experimental and calculated noise level values is that, to some extent, the number of noise events detected by each noise monitor cannot be expected to agree with the number of shots indicated by the range records. The noise monitors cannot discern individual gunshots, but only measure the highest peak level and the total SEL that occurs during any 1-second interval in which the sound level exceeds the trigger level. Many shots may be fired during a one-second interval, especially if there are several shooters on the ranges. Also, only noise events that exceeded 85 dB A-weighted peak level were recorded, which excluded many low-level events. The unavoidable conclusion is that the number of verified experimental "events" (1-second intervals during which gunfire occurred, verified as gunfire by listening to the audio clips) should always be fewer than the number of events indicated by the range records. There were four days when the reverse was true for at least one monitor site: 30 June, 13 July, 14 July, and 7 September. The most likely explanation is that the range records were not reliable. These data were also discarded.

Only those days when firing was, by the above criteria, verified to have occurred were used in the validation process, which reduced the total number of rounds analyzed from over 300,000 to about 166,000. Appendix C presents an annotated summary calendar of all firing that was reported to have occurred during the assessment period from 23 May through 30 October 2001, including information regarding range, weapon, and number of rounds. This calendar was used to generate the ammo report also presented in Appendix C, which was used to carry out SARNAM™ calculation runs.

4.3.1.2 Noise Monitor Data

The Norsonics™ Model 121 noise monitors caused considerable difficulty in executing the project and unexpectedly absorbed considerable resources. Early in the project, late delivery of the noise monitors delayed initiation of the project by several months; had the monitors been received on time, a full year of monitoring could have been completed before the 9/11 attack shortened the small arms monitoring period.

A more serious problem was later discovered. After the SARNAM™ validation analysis was essentially completed, it was discovered that the individual event metric values of overall SEL were unreliable due to an error in the microprocessor-based noise monitor programming. The problem was discovered only after all noise monitor field data had been collected, and all data analysis had been completed; that is, all noise monitor experimental data had been reduced, tables and graphs of all data were completed, all SARNAM™ calculations had been completed, and comparisons had been made to judge SARNAM™ validity. The error affected the value of all total and average SEL values, since they are calculated based on event overall SEL values. The noise monitors had been

programmed to also record the unweighted band SEL values, and testing of the instruments indicated that these were correct, so it was possible to calculate the correct values for overall SEL for each noise event. The data for about 166,000 noise events were reprocessed to correctly calculate all A-weighted Sound Exposure Level (ASEL) values, the new data were re-analyzed, and new tabular and graphical presentations prepared. The noise monitor ASEL calculation error was found to be apparently random and was as large as 16 dB, with a mean error of -4.65 dB and a standard deviation of about 1.5 dB. After the individual noise event overall SEL values were corrected, all tables, graphs, and data comparisons were redone to enable SARNAM™ validation judgments.

4.3.1.3 Validation Data Comparison

Judgment regarding the validity of the SARNAM™ software predictions was made by comparing SARNAM™ calculated noise metrics with the field measurements obtained via the Norsonics™ Model 121 noise monitors. The basic premise of the validation design was that it is appropriate to compare noise levels measured by instruments in the field with those predicted by the SARNAM™ noise model. There are several factors that complicate and can compromise the validity of such a comparison. These must be considered to reach meaningful conclusions and to refine optimal use of the noise model. This section describes the comparisons made, discusses potentially misleading comparisons, arrives at a measure of SARNAM™ validity, and discusses possibilities for improving the software and assessment procedures.

Weapons noise impact assessment practice utilizes long-term average sound exposure levels, which is consistent with accepted practice for other types of noise such as transportation noise due to aircraft and highway traffic (Schultz 1978). Because weapon impulse noise can vary so widely due to weather, average levels can be usefully supplemented by single event levels to better assess community noise impact and response, particularly regarding the likelihood of receiving noise complaints (Pater 1976, Luz et al. 1983, Hede and Bullen 1982, O'Loughlin et al. 1986, Sorenson and Magnusson 1979). Thus both average and single event metrics were examined.

The noise level data, both measured and calculated values, are attached to this report in Appendices D and E. The noise monitor data are the corrected data. Appendix D presents the data for each day on which the combination of monitoring data and range records was judged to be reliable. Appendix E presents the total of all reliable data summarized from the entire sampling period. In each Appendix, two data formats are used. The first is a combination graphical bar chart and numeric data table that presents the noise level values for each monitor site, calculated and measured, for event peak level, total ASEL for the period, and event ASEL. Measured event values are presented in terms of the mean, maximum, and minimum values that were measured. A second data presentation is a tabular presentation of the measured data that shows the number of events (actually, 1-second periods during which gun shot noise events were detected and verified) and the distribution of measured levels in 10 dB intervals for each monitoring site. The charts also identify the date, the weapons that were fired, and the range on which they were fired. These data provide basis for validation conclusions, and also provide information that guides the use of, and interpretation of results from, noise models.

The daily data presented in Appendix D were examined in detail during data analysis, which facilitated understanding the data and drawing conclusions. For the sake of clarity, the analysis and conclusions will be presented here primarily in terms of the summary data presented in Appendix E.

The first row of the tabular presentation of the experimental data, for both individual days (Appendix D) and the summary data (Appendix E), presents the total number of 1-second intervals during which gunfire was detected. The number is generally not the same for all sites, which indicates that the statistical population is incomplete for at least many of the sites. The minimum A-peak value is 85 dB (the trigger level) for many sites in Appendix D and for all sites in Appendix E, which further indicates that the population is probably typically incomplete. In the summary data of Appendix E, site 2 has the largest population (40,732 events), so the standard deviation values for event levels (7.6 dB A-peak, 6.7 dB ASEL) are presumably the most meaningful. For a Gaussian distribution, over 99% of all events are expected to fall within three standard deviations of the mean; for Site 2, this equals a total range in received event level of 45.6 dB in A-peak and 40.2 dB in ASEL. The maximum and minimum values of these variables at Site 2 differ by 39 and 51.5, respectively. The actual ranges are probably larger, since low-level events were no doubt excluded. Causes of variations at any site include measurement error (believed to be less than 1 dB), type of weapon or mix of weapons, distance from source to receiver, and propagation (weather) conditions. This large variation, particularly the variation among individual days, shows the folly of using spot measurements to characterize the noise environment in the environs of a shooting range.

One possible comparison between calculated and measured metric values is peak sound pressure level of individual events at each measurement site. For typical small arms impulsive pressure waveforms, A-weighted peak and unweighted peak are nearly identical, since almost all of the acoustical energy occurs in the portion of the spectrum that is minimally affected by the weighting filter. The effect of wind blowing over a microphone introduces low frequency “noise” into sound measurements; an A-weighting filter excludes most of the spurious signal fluctuations due to wind. Thus the most meaningful comparison that could be made was between SARNAM™ unweighted peak level and measured A-weighted peak level. The data charts present SARNAM™ calculated peak and three experimental metrics, namely mean, maximum, and minimum peak level, as the first four bars on the charts. For each receiver location, SARNAM™ calculates the mean expected value of unweighted peak level for each combination of weapon and source location, for mild downwind conditions, and reports the largest. The experimental values on most days are for a variety of weapons and locations, most of which will yield smaller levels that depress the mean peak. It is therefore expected that the SARNAM™ predictions would be higher than the measured mean, by a margin dependent on the weapon type and location (and can be skewed by weather effects). Examination of the data for individual days, presented in Appendix D, led to the conclusion that the calculated mean peak was almost always larger than the mean measured peak and smaller than the maximum measured peak that occurred during any day. The same conclusions result from examination of the overall data presented in

Appendix E (with the exception of Site 2). While these results are consistent with physics principles, the predictions do not agree with measured values within the target 5 dB goal. The average disagreement between SARNAM™ calculated peak and the measured mean peak, for all days and all sites, is about 23 dB. The discrepancy may be due to errors in weapon type or location, to the mix of weapons on each day, and to the weather. These data serve to substantially improve our understanding of how to interpret both calculated and measured small arms blast noise metric values. It is clear that SARNAM™ could usefully be modified to enable user selection of a variety of statistical measures of each metric, for example both mean and standard deviation, to better convey expected levels. SARNAM ™ should also be modified to predict levels for user-selectable weather classifications. An important conclusion is that single event levels should be separately calculated and analyzed for each type of weapon to be fired on each range.

Judging validity by comparing single event SEL is less illuminating. Event SEL values were calculated by SARNAM™ for one shot. The measured ASEL value during any 1-second measurement period may include several shots. The calculated value reported is the maximum that occurs at a given site for firing noise from potentially several different weapons at several different firing locations. Available data are not sufficient to sort out this situation, since it was not reliably known when or where any given weapon was fired. Also, detailed weather effects are unknown in the experimental data and SARNAM™ does not account for them in calculations. The experience of performing these data comparisons did serve to substantially improve our understanding of how to interpret both calculated and measured small arms blast noise metric values. Examination of these data, however, provided little basis for judging software validity.

Comparison of total ASEL is of considerable interest, since it is the basis for calculating long-term average noise level metrics such as LEQ and DNL. Total ASEL is the aggregate A-weighted sound energy that arrives at a given site. Both the calculated and experimental data in principle should yield the same result. The validity of this comparison is hampered by the uncertain reliability of the range records and the unknown weather effects. After clearly unreliable data had been discarded, the data set encompassed data for a total of 83 measurement sites on 23 days. The difference between calculated and measured ASEL values averaged across all of the data was about 14 dB. This does not meet the performance criterion of 5 dB. While we expected that SARNAM™ over-predicts somewhat, as a consequence of a development budget cut that forced use of a single weather case propagation algorithm, namely mild downwind conditions, this is a larger discrepancy than was expected. Possible explanations include the lack of winter data, and uncertainty regarding whether the correct weapon or number of rounds was reported. The data are thus not adequate for conclusive judgment of the validity of the noise model predictions. A “perfect” study would require ranges operating under strict controls, which is neither fiscally nor operationally feasible. The study was nevertheless very valuable for identifying needed software improvements, and also for identifying how best to use the noise model to perform optimized noise management consultation.

4.3.1.4 Summary of Validation Conclusions

The discrepancy between predictions and measurements may be the result of inaccurate range firing records; accurate input information regarding weapon type, location, and number of rounds fired is critically required for accurate results. A "perfect" study would have the firing ranges operating as controlled environments, which is neither fiscally nor operationally feasible. Another possible contributing factor is that, due to unanticipated closure of the range, no winter firing days were included in the assessment period; noise levels can be expected to be substantially higher in winter than in summer because of refraction caused by prevailing wind and temperature structure in the atmosphere.

SARNAM™ calculates the mean expected value of various noise level metrics for mild downwind conditions. Further, this calculation is used in all directions. It is known that wind can cause sound level to increase by several dB in the downwind direction, while the sound level can be as much as 15 dB lower in the upwind direction, compared to calm conditions. The calculation algorithms used in SARNAM™ were previously verified to be accurate under known weather conditions of mild downwind conditions. Budget reductions during SARNAM™ development prevented inclusion of options to account for detailed weather effects, for example by means of a "wind rose." A consequence is that the present version of SARNAM™ can be expected to yield a somewhat worst-case assessment under most conditions, since the wind cannot be blowing in all directions at any one time. This project provided the first opportunity to assess the impact of long-term weather variation effects on the accuracy of the assessment. On any given day, "average" conditions will not occur, and so agreement between predicted and measured values cannot be. However, because of the way decibel arithmetic works, higher values dominate the final metric values for total and average SEL, so a wide variety of weather conditions, particularly varying wind direction, were expected to yield reasonable agreement. It is clear that SARNAM™ could significantly benefit from additional weather classifications to predict both single event levels and average levels more accurately. It would also be highly useful to predict not only the mean level but also some measure of expected statistical variance. A software upgrade is planned to address these needed improvements.

The authors also conclude that single event levels should be separately calculated and analyzed for each type of weapon to be fired on each range. Such single event levels are probably at least as important as long-term average noise levels. Further research could illuminate the relative importance of single event noise and long-term average noise for determining community attitude toward the noisy activity.

A noise model validation study of the type undertaken in this project can be conclusive only if all important parameters, including firing event data and atmospheric parameters that affect sound propagation, are measured. As long as SARNAM™ cannot accurately predict received sound level for specific weather conditions, or if specific weather conditions are unknown, for example when making calculations in the past or future, agreement between measurements and calculations cannot be expected on an absolute scale. SARNAM™ remains the only software package available to assess small arms noise, and provides valuable noise mitigation guidance. In particular, the software is

highly valuable for assessing the effect of changes in range location, physical structure, or operation, for the purpose of reducing noise in the community.

4.3.2 Data Analysis: Demonstration at Camp Ava

The SARNAM™ software application was used in the planning of a Multi-Purpose Machine Gun (MPMG) .50 Caliber Range at “Camp Ava.” The noise reduction consultation performed for Camp Ava serves to demonstrate the time and cost saving benefits and the noise reduction potential of SARNAM™. The actual name of the installation, and actual map features, are not used in this demonstration description to avoid revealing facility information that may compromise operational security. The presentation is faithful to meaningful illustration of the noise analysis and results.

Noise impact assessment, as the basis for recommendations for reducing identified impacts, was carried out according to DoD land use and compatibility principles and guidelines. In 1980 the Federal Interagency Committee on Urban Noise (FICUN 1980) developed land use guidelines, adopted by the DoD, for areas on and/or near noise producing activities, such as highways, airports, and firing ranges. The Army’s Installation Noise Management Program (INMP), as well as the other Services’ programs, uses the guidelines, which are presented in Table 3. The DA PAM 200-1 (2002) designates Noise Zones for land use planning. By projecting these zones onto an area map, land use guidelines can help planners develop compatible land uses and reduce noise impacts. The borders of the zones are defined by noise level contours of specific values. Noise level contours should be viewed as indications of the local noise environment, not as the boundary between acceptable and unacceptable noise levels; stepping across the location on the ground of a noise contour does not result in a sudden change in the noise environment. The guidelines, based on long-term average noise exposure levels, are based on a significant body of research results (CHABA 1981, CHABA 1996). The guidelines are consistent with the methodology and guidance that is accepted practice for other types of noise such as transportation noise due to aircraft and highway traffic (Schultz 1978). Because weapon impulse noise can vary so widely due to weather (Schomer and Luz 1978), average levels can be usefully supplemented by single event levels to more accurately assess community noise impact, particularly regarding the likelihood of receiving noise complaints (Pater 1976, Hede and Bullen 1982, Luz et al. 1983, O’Loughlin et al. 1986, Sorenson and Magnusson 1979).

Table 3. Land Use Planning Guidelines (DA PAM 200-1, 2002).

Noise Zone (See Appendix A)	Noise Limits			
	Population Highly Annoyed	Transportation ADNL	Impulsive CDNL	Small Arms ADNL
I	< 15 %	< 65 dBA	62 dBC	< 65 dBA
II	15 – 39 %	65 - 75 dBA	62 – 70 dBC	65 - 75 dBA
III	> 39 %	> 75 dBA	> 70 dBC	> 75 dBA

ADNL = A-weighted Day-Night Average Sound Level
CDNL = C-weighted Day-Night Average Sound Level
dBA = decibels, A-weighted
dBC = decibels, C-weighted

In March 2003, Camp Ava planned to construct an MPMG range. To assist Camp Ava in the siting of the range to reduce noise impacts on neighboring communities, SARNAM™ was used by USACHPPM to examine alternative range site scenarios. Several range sites and variations in range construction were considered as possible means to reduce the noise levels in the community. Four alternatives were considered in detail and are described here.

(1) Figure 16 shows the noise zones, calculated by means of SARNAM™, for the installation's initial concept of the new MPMG range. Noise Zone III, which is normally deemed suitable only for land uses such as industry or agriculture that are not highly sensitive to noise, extended off-post. Noise Zone II, normally not recommended for noise-sensitive land uses, including residential areas, protruded a considerable distance into the community.

(2) Figure 17 shows the noise contours for the proposed MPMG range operations if the location was moved 500 meters to the east. This yielded a significant noise level reduction beyond the western camp boundary.

(3) In alternative 3, noise barriers were added to the original location to reduce community noise levels. Several design options were considered, including factors such as barrier size, location, construction, cost, access to the range, maintenance, drainage, resulting sound level reduction in the community, and safety during firing exercises. A range design was selected that utilized earthen berms six meters high, with a berm located 10 meters behind the firing line and additional berms 10 meters long on both sides of the firing line. This design also resulted in significant noise impact reduction off camp. Figure 18 shows the resulting change in noise contours.

(4) In alternative 4, noise barriers were added and the location was moved 500 meters to the east of the original location. Figure 19 shows the resulting noise contours for the proposed MPMG range operations. This option significantly reduced the noise impact beyond the camp boundary, and also improved range safety. The changes enable reductions in community noise level of at least 5 dB, and as much as 10 dB in portions of the contiguous community that are located near the installation boundary. This reduction in noise level substantially exceeds the noise reduction goal of 4 to 5 dB.

In summary, for the original range design and site, unacceptably high noise levels extended beyond the western boundary, high enough that the range would probably elicit numerous noise complaints and so be a long-term training operation problem. Moving the range and adding berms significantly reduced the noise impact, yielding a 5 to 10 dB less noisy noise environment in various portions of the populated regions around the camp. The lower sound levels are less likely to cause adverse community reaction, and exceed the performance the goal of at least a 4 to 5 dB noise reduction.

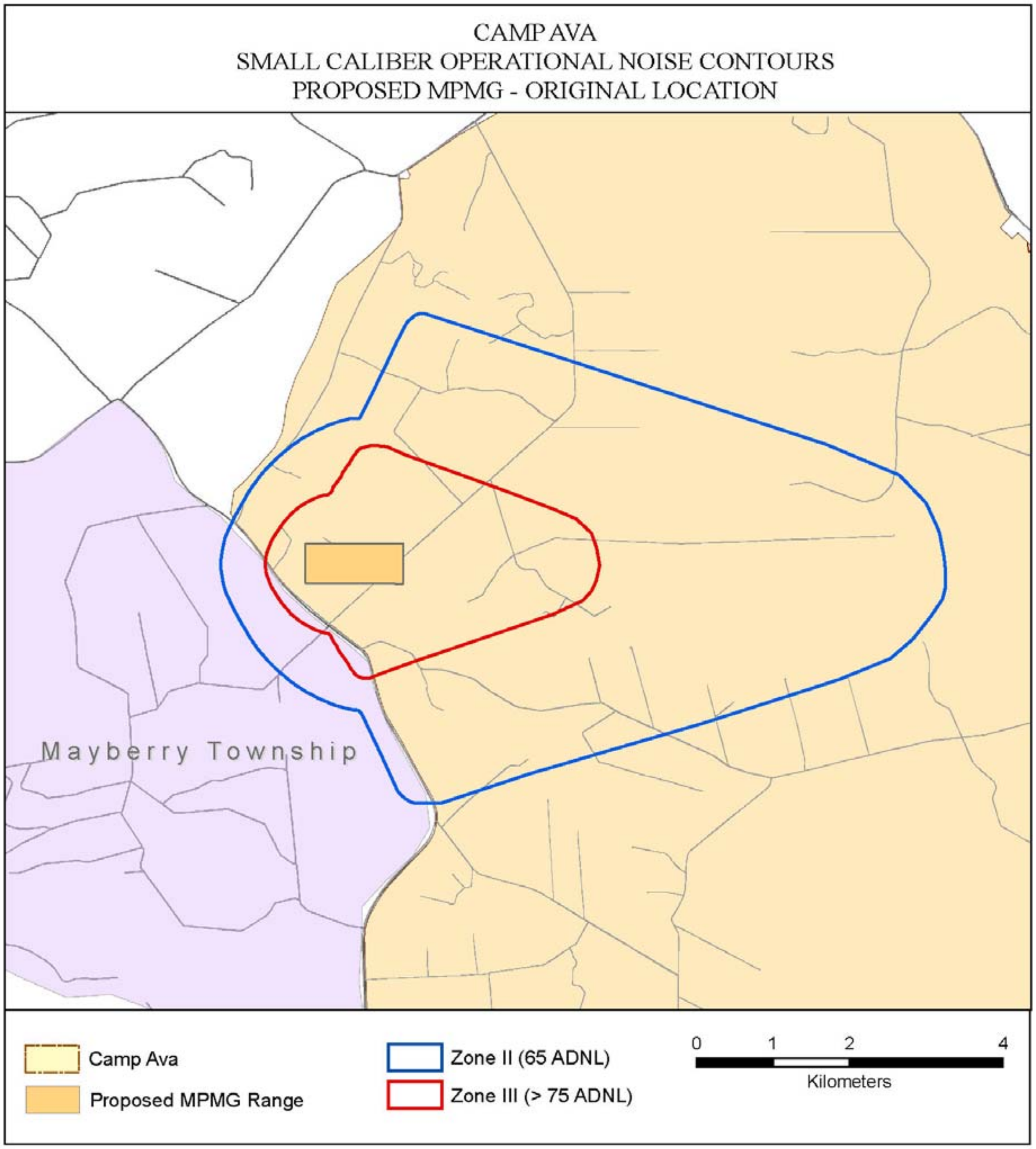


Figure 16. Initially proposed location of the new range.

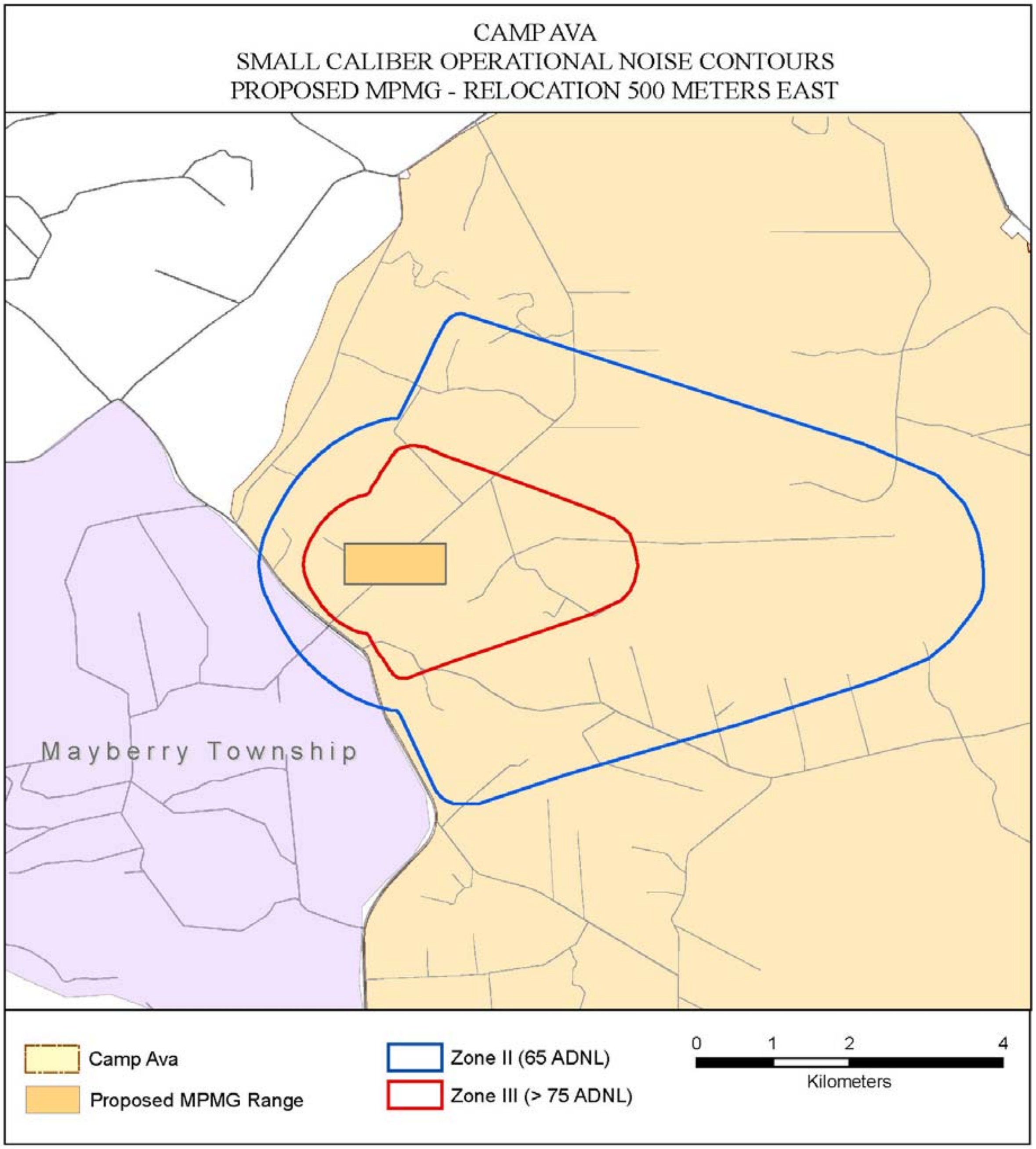


Figure 17. Alternate range location.

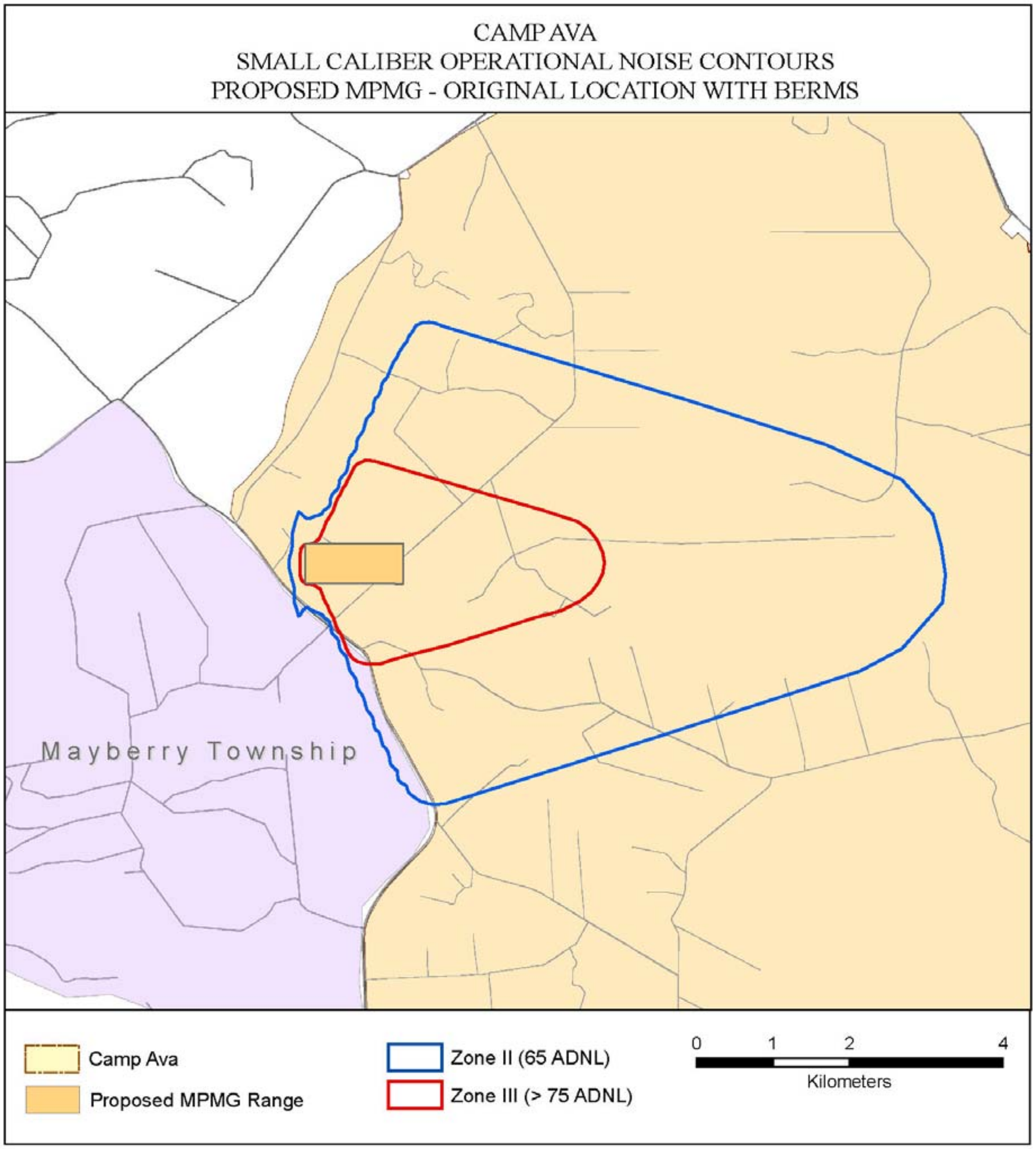


Figure 18. Range alternative with berms added.

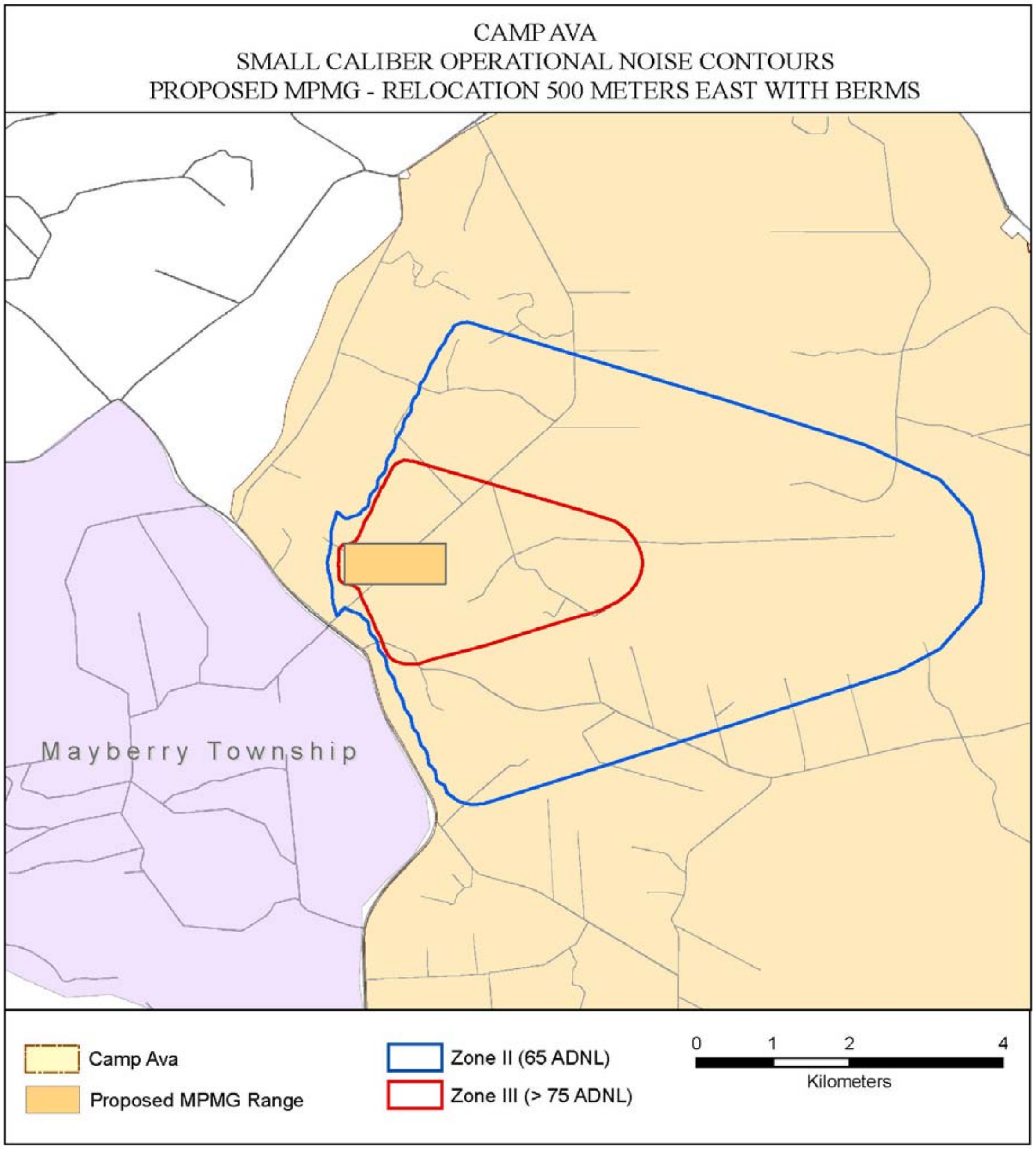


Figure 19. Contours for both changed location and added berms.

5. Cost Assessment

5.1 Cost Reporting

A quantifiable performance objective of the noise model demonstration is a 20% reduction in overall cost associated with the SARNAM™ software. One consideration is the startup cost of using the SARNAM™ noise software. Another is the cost of using SARNAM™ to perform a noise assessment, compared with the cost of using previous methods that involved modeling done via hand calculations and noise sampling. Still another cost consideration is the savings that result from operating a range complex according to recommendations that result from SARNAM™ analysis, compared with the costs of operating without benefit of noise software guidance. Factors include cost considerations associated with damage claims, closure of ranges, land acquisition costs, costs of loss of training days and training acres, and noise complaints. These cost benefits are difficult to evaluate conclusively. An estimate of the cost of training and testing noise to the Army, and what cost reduction can be realized through a noise management program based on technology and public outreach is presented in Appendix F. The overall cost of noise to the Army is very large, but was not included in this cost assessment. An example of lost training and lost construction funds is the deactivation of a new multi-million small arms range that was sited without a noise assessment, and was abandoned and rebuilt in another location because of adverse community reaction to noise. Such large cost savings, plus the desire to be a good neighbor, motivate installations to perform noise impact analysis using the SARNAM™ noise software.

5.2 Cost Analysis

The startup costs associated with using noise software to guide noise management are small. They consist of the cost of an ordinary personal computer, if a suitable one is not already available, and the cost of training the user to use the software. Assuming that the user is familiar with training procedures and the weapons of interest, and has some acoustics knowledge, the cost of the training and familiarization is about 40 hours of labor per user, usually a total of less than $4K per user. The SARNAM™ software is provided free of charge.

The cost of using SARNAM™ to perform a noise assessment occurs at the user level, either at the installation or at USACHPPM or a contractor for cases in which the installation itself cannot or does not wish to carry out the noise analysis. In cases where the installation contracts with USACHPPM or with another consultant to carry out noise analyses, the cost will depend on how extensive is the required noise impact analysis; costs can range from nearly zero to as much as $100K. The cost picture must also include considerations of USACHPPM mission funding leveraging, and of private contractors' additional costs of profit. Much of the cost of an assessment is obtaining and validating the training data that constitutes the input data for the assessment.

A cost analysis is presented here for the assessment that is the subject of the demonstration performance evaluation for Camp Ava. During the NEPA process for placement of the MPMG range, several scenarios were examined to determine the best range location and design for reduced noise impacts on surrounding communities. The demonstration cost was approximately $15,000, which includes report writing and reproduction, as detailed in Table 4.

Table 4. Cost Comparison

Previous Method --- On-site Noise Monitoring*		
	Labor cost	**Man hours**
Preliminary hand calculation of noise levels by project officer	$14,770	200
Equipment maintenance/preparation by technicians	$5,200	160
Equipment supplies & shipping	$913	n/a
On-site monitoring labor		240
Project officer	$5,908	
Technicians	$5,200	
Data analysis by project officer	$5,908	80
Report		
Project officer	$2,954	40
Senior project officer	$1,780	20
Admin	$492	15
Total Cost	$43,125	755
**Cost analysis is based upon a 2-week onsite monitoring study with one project officer and two technicians. This figure does not include travel expenses, i.e. airfare, hotel, per deim, rental vehicle.*		
Demonstration Method --- SARNAM™		
	Labor cost	**Man hours**
Noise assessment via SARNAM™	$9,914	120
Report		
Project officer	$3,305	40
Senior project officer	$1,780	20
Admin	$492	15
Total Cost	$15,000	195
	Labor Cost Savings	**Man Hour Savings**
Total SARNAM™ Cost savings	$28,125	560
	65.22%	74.17%

5.3 Cost Comparison

The cost comparison presented in Table 4 addresses the cost benefits of using SARNAM™ to perform a specific noise assessment of a proposed range verses the previous method of on-site monitoring and hand calculations. Prior to SARNAM™ the only way to perform noise impact assessment for small arms ranges was by hand calculation of received noise, in conjunction with conducting a minimum 2-week on-site monitoring study, followed by approximately 2 weeks for monitoring data analysis and 1 week for report writing. The Camp Ava project using the pre-SARNAM™/manual methods would have cost $43,125 and 755 man-hours. The use of SARNAM™ reduced the cost by $28,125 or 560 man-hours. The overall savings in costs and man-hours allows USACHPPM to provide faster and more cost-effective service to DoD. This cost reduction amounts to 65%, which easily meets the 20% cost reduction goal.

Additional cost savings are realized at installations as a result of effective management of noise emission from ranges. These cost benefits are difficult to evaluate accurately. An analysis of the surprisingly high cost of training and testing noise to the Army, and what cost reduction can be realized through a noise management program based on technology and outreach to the public, is presented in Appendix F.

SARNAM™ reduces the resources needed to manage noise impacts from existing and proposed ranges throughout DoD. It reduces the cost to assess noise impacts and examine alternative scenarios for both testing and training range operations and planning by more than 20%. The cost benefits of maintaining viable training capability in the face of encroachment of a population that is increasingly less tolerant of degradation of their living environment are huge.

6. Implementation Issues

6.1 Environmental Checklist

Regulatory drivers are discussed earlier in this report. No permits were required for the field validation project. The neighbors were notified of the project and landowner permission was secured to locate monitors at those sites that were outside of the installation boundary.

6.2 Other Regulatory Issues

There are no national regulations regarding weapons blast noise. Current “regulation” amounts to self-regulation by the installation to maintain noise at levels acceptable to community residents. This is done by a combination of technology, planning, and public outreach. Information generated by SARNAM™ is used by USACHPPM in consultation with installations to minimize noise problems, and is available to the installations and the public. Noise models such as SARNAM™ have been formally integrated into Huntsville range design manuals. SARNAM™ provides the means to maintain a balance between mission execution and environmental quality for both civilian and military personnel living in the area.

6.3 End-User Issues

The primary end-user is USACHPPM; others include contractors who perform noise assessments for installations, and installation personnel including master planners, trainers, and range

operators. All of them are concerned about accuracy, cost, and ease of use. SARNAM™ gives the DoD, public law enforcement agencies, and the private sector, a tool for noise management from small arms ranges that was not previously available. Noise emission depends strongly on the type of weapons fired, which is dictated by training requirements. The noise dose in the community can be influenced by several controllable factors, particularly by the location of the firing, by the design and orientation of the range, noise barriers, acoustical absorption materials on barriers and baffles, by selecting the time and weather conditions when the firing occurs, and by the number of noise events. The SARNAM™ software enables examination of noise reduction options quickly and with relative ease; once the initial input file is created, the software allows rapid calculation of alternatives. A "getting started" manual (Pater et al. 1999) is available to guide the user. The software runs on ubiquitous personal computers under the Windows™ operating system. The Army developed the SARNAM™ software, so there are no proprietary considerations. Optimal use of the software requires familiarity with acoustical principles, weapons, and training procedures.

The previous technology for assessment or mitigation of small arms range noise was field measurements, supplemented by hand calculations of received noise level. The extreme variability of received noise due to changes in propagation conditions (weather) severely limits the general applicability of measurements for accurately determining the prevailing noise environment. The quality of calculation of received noise level was dependent on knowledge of an esoteric field and on the availability of source models for small weapons. The efficiency of rapid calculation, elimination of human error during calculations, and the extensive set of weapons for which calculations can be easily made, represent significant advances in capability.

This project provided the first opportunity to test SARNAM™ exhaustively and in detail for accuracy and performance in assessing training noise impact under conditions of actual training at an installation over a protracted time period. The utility of the software for noise mitigation was demonstrated. An extremely favorable cost performance was also shown. The project revealed the extreme importance of reliable training activity data, particularly regarding the type of weapons and the number of rounds fired on each range throughout the assessment period. The noise monitor measurements showed the extreme variability of received noise level. The lack of agreement between calculated and measured noise levels caused the researchers to conclude that there is the need to modify SARNAM™ to offer the user a selection of weather conditions. This has been done for two other blast noise models, and was intended for SARNAM™ but was prevented by development budget cuts. SARNAM™ remains the only software package available to calculate and display weapons noise contours due to weapons impulsive noise, which greatly facilitates assessment of noise impacts and evaluation of noise mitigation options. Results of this project will guide improvement of current and new noise impact assessment software. Results of this study are also of value for guiding how the DoD conducts noise impact assessment. The difficulty of obtaining accurate data for the number of rounds fired means that average noise metric values are of dubious utility; this is one reason for using single event metric noise levels, since weapon type and location are comparatively easy to ascertain accurately. This project will result in improvement in noise assessment software and procedures that will contribute to sustainable training capability. Of particular note is the fact that the project brought home the realization that the most important use of a noise model such as SARNAM™ is not to

predict the absolute noise level in the community, but rather as a mitigation tool to reduce and manage noise disturbance and environmental quality.

The absolute accuracy of SARNAM™ noise predictions remains unproven, and in any case is to some extent not of primary interest, given the large variance in received noise level due to weather conditions and the lack of noise laws that limit noise levels. The most important use of SARNAM™ is noise management by striking a balance between mission execution and environmental quality. Reliable guidance regarding noise level reduction under a wide range of conditions is arguably more important than the absolute accuracy of noise level predictions for specific conditions.

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Appendix A
Glossary of Terms

A-Weighted Sound Level - The ear does not respond equally to sounds of all frequencies, but is less efficient at low and high frequencies than it is at medium or speech range frequencies. Thus, to obtain a single number representing the sound pressure level of a noise containing a wide range of frequencies in a manner approximating the response of the ear, it is necessary to reduce, or weight, the effects of the low and high frequencies with respect to the medium frequencies. Thus, the low and high frequencies are de-emphasized with the A-weighting.

The A-scale sound level is a quantity, in decibels, read from a standard sound-level meter with A-weighting circuitry. The A-scale weighting discriminates against the lower frequencies according to a relationship approximating the auditory sensitivity of the human ear. The A-scale sound level measures approximately the relative "noisiness" or "annoyance" of many common sounds.

Community - Community means those individuals, organizations, or special interest groups affected by or interested in decisions affecting towns, cities, or unincorporated areas near or adjoining a military installation; and officials of local, State, and Federal governments, and Native American tribal councils responsible for decision making and administration of programs affecting those communities.

Day-Night Average Sound Level (DNL) - The 24-hour average frequency-weighted sound level, in decibels, from midnight to midnight, obtained after addition of 10 decibels to sound levels in the night from midnight up to 7 a.m. and from 10 p.m. to midnight (0000 up to 0700 and 2200 up to 2400 hours). A-Weighting is understood unless otherwise specified.

Decibels (dB) - The decibel is a logarithmic unit of measure of sound pressure.

Demonstration - For the purposes of this report, demonstration refers to the use of computer software to calculate and display noise contour. Demonstration did not include field monitoring.

Equivalent Sound Level (LEQ) - The level of a constant sound which, in a given situation and time period, has the same energy as does a time varying sound. For noise sources, which are not in continuous operation, the equivalent sound level may be obtained by summing individual sound exposure level (SEL) values and normalizing over the appropriate time period.

Frequency - Number of complete oscillation cycles per unit of time. The unit of frequency is the Hertz.

Hertz - Unit of frequency equal to one cycle per second.

Impulse Noise (Impulsive Noise) - Noise of short duration (typically less than 1 second), especially of high intensity, abrupt onset, and rapid decay, and often rapidly changing spectral composition. Impulse noise is characteristically associated with such sources as explosions, impacts, the discharge of firearms, the passage of supersonic aircraft (sonic boom) and many industrial processes.

Noise - Sound that is deemed by an observer to be annoying, objectionable, or without value.

Noise Exposure - The cumulative acoustic stimulation reaching the ear of a person over a specified period of time (e.g., a work shift, a day, or a lifetime).

Noise Zone III - Noise Zone III consists of the area around the noise source in which the level is greater than 70 decibels (dB) C-weighted day-night average sound level (CDNL) for large caliber weapons or greater than 75 dB A-weighted day-night average sound level (ADNL) for small caliber weapons. Noise-sensitive land uses (such as housing, schools, and medical facilities) are not recommended within Noise Zone III.

Noise Zone II - Noise Zone II consists of an area where the DNL is between 62 and 70 dB CDNL for large caliber weapons or between 65 and 75 dB ADNL for small caliber weapons. Land within Noise Zone II should normally be limited to activities such as industrial, manufacturing, transportation, and resource production. However, if the community determines that land in Noise Zone II (attributable to small arms) areas must be used for residential purposes, then noise level reduction (NLR) features of 25 to 30 decibels should be incorporated into the design and construction of new buildings to mitigate noise levels. For large caliber weapons, NLR features can not adequately mitigate the low-frequency component of large caliber weapons noise.

Noise Zone I - Noise Zone I includes all areas around a noise source in which the day-night sound level is less than 62 dB CDNL for large caliber weapons and less than 65 ADNL for small arms weapons. This area is usually acceptable for all types of land use activities.

Sound Exposure (SE) - The integral of sound pressure squared integrated over a specified time period.

Sound Exposure Level (SEL) - Defined as 10 times the base 10 logarithm of a quantity consisting of the sound exposure divided by an appropriate standardized reference quantity.

Validation - For the purposes of this report, validation refers to the field monitoring performed at Marseilles Training Site.

Appendix B
Data Quality Assurance/Quality Control Plan

The purpose of this quality assurance plan was to ensure that the facilities, equipment, personnel, methods, practices, records, and controls would result in high quality, scientifically defensible data and technology that will meet user needs. The Quality Assurance Officer was Ms. Catherine M. Stewart, USACHPPM.

ERDC/CERL, the developer of the software, carried out the noise data acquisition required for noise software validation, including collecting the data and maintaining records. USACHPPM, as the expert user and the entity with assigned mission responsibility for noise technology user advocacy, judged the accuracy and utility of the software and monitored data acquisition and archiving. USACHPPM visited each site twice, once during or soon after setup and once several months later, to ensure that proper procedures were in place.

The completeness of the validation data was ensured by measuring real, actual data; that is, by measuring all of the noise produced by all of the training at an installation that carries out typical intensive military training. This is important because noise impact is assessed, according to standardized procedures, on an annual basis. Received noise levels vary widely during the day and during the year.

Standard calibration procedures for noise measurement equipment consisted of using a type of microphone calibration device known as a pistonphone. The entire system is calibrated, since even changing an interconnection cable can change the received signal and thus invalidate the data. Professional quality noise measurement equipment in general, and the Norsonics™ 121 monitors in particular, are extremely stable. The calibration was checked each time the equipment was visited to download data and replace the batteries. The nature of calibration drift is such that, in the extremely unlikely event that any should be encountered, the data can be readily corrected. It is also possible, though extremely unlikely, that a microphone or some other aspect of the noise monitor equipment might fail. This would simply mean that data would not be obtained at all of the monitoring sites for all of the events.

A noise event is defined as a sound of a level that that exceeds a user-selected threshold. Data reporting format and content were tailored during setup of the Norsonics™ equipment; the setup file was generated once, on one machine, and transferred to all others to reduce the chance of error. The quantities to be measured were specified in the setup file. Data reports were available as digital computer files. Each event was recorded in entirety by means of a pre-trigger feature that was provided by the equipment manufacturer at our request and according to our specification. The equipment also recorded an audio clip of each event. Data reduction included listening to each recorded noise event to ensure that it was actually a weapons blast noise event, thus ensuring that our data was actually representative of actual training noise, and did not include extraneous noise such as wind, car door slams, and bird calls.

Appendix C
Range Activity

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
	21-May-01	22-May-01	23-May-01	24-May-01	25-May-01	26-May-01	27-May-01
RANGE A			5.56	5.56, 12g, 22l/r			
RANGE B			5.56				
RANGE C			5.56				
RANGE D			45 cal, 9mm				
site 1			unit down	EVENTS			
site 2			unit down	EVENTS			
site 3			unit down	unit down			
site 4			EVENTS	unit down			
site 5			EVENTS	unit down			
site 6			EVENTS	unit down			
site 7			unit down	unit down			
site 8			unit down	EVENTS			
site 9			unit down	unit down			
	28-May-01	29-May-01	30-May-01	31-May-01	1-Jun-01	2-Jun-01	3-Jun-01
RANGE A			12g, 9mm			5.56, 7.62	
RANGE B							
RANGE C							
RANGE D		9mm		9mm			
site 1						EVENTS	
site 2						EVENTS	
site 3						EVENTS	
site 4						EVENTS	
site 5		? ammo report	? ammo report	? ammo report		EVENTS	
site 6						EVENTS	
site 7						EVENTS	
site 8						no events	
site 9						EVENTS	
	4-Jun-01	5-Jun-01	6-Jun-01	7-Jun-01	8-Jun-01	9-Jun-01	10-Jun-01
RANGE A			45 cal		5.56		
RANGE B					5.56		
RANGE C			45 cal	45 cal			
RANGE D	45 cal						
site 1	EVENTS			no events	no events		
site 2	EVENTS		EVENTS	EVENTS	no events		
site 3	no events			no events	no events		
site 4	EVENTS		unit servicing	EVENTS	no events		
site 5	no events			EVENTS	no events		
site 6	EVENTS			EVENTS	EVENTS		
site 7	no events			no events	no events		
site 8	EVENTS		EVENTS	no events	EVENTS		
site 9	EVENTS		unit down	unit down	unit down		
	11-Jun-01	12-Jun-01	13-Jun-01	14-Jun-01	15-Jun-01	16-Jun-01	17-Jun-01
RANGE A		5.56		5.56	5.56		
RANGE B			5.56	5.56	5.56		
RANGE C					5.56		
RANGE D							
site 1		EVENTS	EVENTS	EVENTS	EVENTS		
site 2		EVENTS	EVENTS	EVENTS	EVENTS		
site 3		EVENTS	EVENTS	EVENTS	EVENTS		
site 4		EVENTS	EVENTS	EVENTS	EVENTS		
site 5		EVENTS	EVENTS	EVENTS	EVENTS		
site 6		unit down	unit down	unit down	unit down		
site 7		no events	unit down	unit down	unit down		
site 8		unit down	unit down	unit down	unit down		
site 9		no events	EVENTS	EVENTS	unit down		
	18-Jun-01	19-Jun-01	20-Jun-01	21-Jun-01	22-Jun-01	23-Jun-01	24-Jun-01
RANGE A		5.56, 9mm	5.56, 9mm		5.56, 9mm		
RANGE B							
RANGE C							
RANGE D							
site 1					no events		
site 2					no events		
site 3					no events		
site 4		unit servicing	unit servicing		no events raining		
site 5					EVENTS		
site 6			EVENTS		EVENTS		
site 7					no events		
site 8					unit down		
site 9					unit down		

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
	25-Jun-01	26-Jun-01	27-Jun-01	28-Jun-01	29-Jun-01	30-Jun-01	1-Jul-01
RANGE A							
RANGE B			5.56				
RANGE C							
RANGE D						45 cal, 9mm	
site 1			EVENTS			unit down	
site 2			EVENTS			EVENTS	
site 3			no events			EVENTS	
site 4			unit down			unit down	
site 5			no events			no events	
site 6			EVENTS			no events	
site 7			EVENTS			no events	
site 8			unit down			no events	
site 9			EVENTS			EVENTS	
	9-Jul-01	10-Jul-01	11-Jul-01	12-Jul-01	13-Jul-01	14-Jul-01	15-Jul-01
RANGE A							
RANGE B							
RANGE C	12g, 5.56	12g, 5.56			9mm	5.56	5.56
RANGE D	9mm	9mm				9mm	
site 1					EVENTS	EVENTS	
site 2	EVENTS				EVENTS	EVENTS	
site 3					no events	EVENTS	
site 4					EVENTS	unit down	
site 5	unit servicing	unit servicing			EVENTS	EVENTS	? ammo report
site 6					EVENTS	EVENTS	
site 7					no events	no events	
site 8					EVENTS	EVENTS	
site 9					no events	no events	
	16-Jul-01	17-Jul-01	18-Jul-01	19-Jul-01	20-Jul-01	21-Jul-01	22-Jul-01
RANGE A		5.56					9mm
RANGE B							
RANGE C					5.56	5.56	5.56
RANGE D						9mm	
site 1						unit down	unit down
site 2						unit down	unit down
site 3						unit down	unit down
site 4						EVENTS	EVENTS
site 5		unit servicing			? ammo report	EVENTS raining	no events raining
site 6						no events	no events
site 7						no events	no events
site 8						EVENTS	EVENTS
site 9						no events	unit down
	23-Jul-01	24-Jul-01	25-Jul-01	26-Jul-01	27-Jul-01	28-Jul-01	29-Jul-01
RANGE A					12g, 9mm		
RANGE B							
RANGE C					9mm	5.56	
RANGE D							9mm
site 1					unit down	unit down	
site 2					EVENTS	EVENTS	
site 3					no events	EVENTS	
site 4					bkgnd. interference	EVENTS	
site 5					no events	no events	? ammo report
site 6					EVENTS	no events	
site 7					EVENTS	EVENTS	
site 8					EVENTS	no events	
site 9					EVENTS	EVENTS	
	20-Aug-01	21-Aug-01	22-Aug-01	23-Aug-01	24-Aug-01	25-Aug-01	26-Aug-01
RANGE A				5.56			
RANGE B				5.56	5.56		
RANGE C				5.56, 9mm			45 cal, 12g, 9mm
RANGE D							
site 1				EVENTS	EVENTS		
site 2				no events	no events		
site 3				EVENTS	no events		
site 4				no events	no events		
site 5				no events	no events raining		? ammo report
site 6				no events	EVENTS		
site 7				no events	EVENTS		
site 8				EVENTS	unit down		
site 9				no events	EVENTS		

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
	27-Aug-01	28-Aug-01	29-Aug-01	30-Aug-01	31-Aug-01	1-Sep-01	2-Sep-01
RANGE A	9mm						
RANGE B							
RANGE C	9mm	5.56					
RANGE D			9mm				
site 1							
site 2							
site 3							
site 4							
site 5							
site 6	? ammo report	? ammo report	? ammo report				
site 7							
site 8							
site 9							
	3-Sep-01	4-Sep-01	5-Sep-01	6-Sep-01	7-Sep-01	8-Sep-01	9-Sep-01
RANGE A					5.56	9mm	
RANGE B					5.56		
RANGE C						5.56	
RANGE D						9mm	
site 1					EVENTS	EVENTS	
site 2					EVENTS	EVENTS	
site 3					EVENTS	EVENTS	
site 4					unit down	unit down	
site 5					EVENTS	no events	
site 6					no events	no events	
site 7					no events	no events	
site 8					EVENTS	EVENTS	
site 9					no events	no events	
	10-Sep-01	11-Sep-01	12-Sep-01	13-Sep-01	14-Sep-01	15-Sep-01	16-Sep-01
RANGE A				5.56			
RANGE B					5.56		
RANGE C							
RANGE D							
site 1				no events	no events		
site 2				EVENTS	EVENTS		
site 3				no events	no events		
site 4				EVENTS	bkgd. interference		
site 5				EVENTS	no events		
site 6				EVENTS	EVENTS		
site 7				UNIT PULLED FROM MONITORING STUDY --			
site 8				EVENTS	EVENTS		
site 9				EVENTS	unit down		
	17-Sep-01	18-Sep-01	19-Sep-01	20-Sep-01	21-Sep-01	22-Sep-01	23-Sep-01
RANGE A			5.56		5.56	50cal, 7.62	
RANGE B							
RANGE C						5.56	
RANGE D						9MM	
site 1			EVENTS		no events	no events	
site 2			EVENTS		EVENTS	EVENTS	
site 3			EVENTS		EVENTS	EVENTS	
site 4			EVENTS		EVENTS	EVENTS	
site 5			EVENTS		unit down	EVENTS	
site 6			EVENTS		EVENTS	EVENTS	
site 7	UNIT PULLED FROM MONITORING STUDY --						
site 8			EVENTS		EVENTS	EVENTS	
site 9			no events		no events	no events	
	24-Sep-01	25-Sep-01	26-Sep-01	27-Sep-01	28-Sep-01	29-Sep-01	30-Sep-01
RANGE A					22 l/r, 12g, 5.56		
RANGE B							
RANGE C							
RANGE D							
site 1					no events		
site 2					no events		
site 3					no events		
site 4					no events		
site 5					EVENTS		
site 6					EVENTS		
site 7	UNIT PULLED FROM MONITORING STUDY --						
site 8					EVENTS		
site 9					unit down		

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
	1-Oct-01	2-Oct-01	3-Oct-01	4-Oct-01	5-Oct-01	6-Oct-01	7-Oct-01
RANGE A							
RANGE B							
RANGE C	45 cal	45 cal	45 cal				
RANGE D							
site 1		EVENTS	EVENTS				
site 2		EVENTS	EVENTS				
site 3		EVENTS	EVENTS				
site 4		EVENTS	EVENTS				
site 5		EVENTS	EVENTS				
site 6		no events	no events				
site 7	UNIT PULLED FROM MONITORING STUDY ----------						
site 8		no events	no events				
site 9		unit down	unit down				

? ammo report — windy — raining — raining

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
	8-Oct-01	9-Oct-01	10-Oct-01	11-Oct-01	12-Oct-01	13-Oct-01	14-Oct-01
RANGE A							
RANGE B							
RANGE C							
RANGE D							
site 1							
site 2							
site 3							
site 4							
site 5							
site 6							
site 7	UNIT PULLED FROM MONITORING STUDY ----------						
site 8							
site 9							

raining — raining — raining — raining

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
	15-Oct-01	16-Oct-01	17-Oct-01	18-Oct-01	19-Oct-01	20-Oct-01	21-Oct-01
RANGE A	5.56						
RANGE B							
RANGE C			45 cal, 12g	45 cal, 12g		5.56	
RANGE D							
site 1	EVENTS		EVENTS	EVENTS		EVENTS	
site 2	EVENTS		EVENTS	EVENTS		unit down	
site 3	EVENTS		EVENTS	EVENTS		EVENTS	
site 4	EVENTS		EVENTS	EVENTS		EVENTS	
site 5	EVENTS		EVENTS	no event		no events	
site 6	EVENTS		EVENTS	no events		no events	
site 7	UNIT PULLED FROM MONITORING STUDY ----------						
site 8	EVENTS		EVENTS	EVENTS		EVENTS	
site 9	no events		EVENTS	EVENTS		EVENTS	

raining — raining — windy

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
	22-Oct-01	23-Oct-01	24-Oct-01	25-Oct-01	26-Oct-01	27-Oct-01	28-Oct-01
RANGE A	9mm	5.56, 9mm	5.56		5.56	7.62	
RANGE B		5.56	5.56		5.56		5.56
RANGE C			45 cal, 12g	45 cal, 12g			5.56
RANGE D						9mm	
site 1	EVENTS	no events	EVENTS	no events	EVENTS	EVENTS	EVENTS
site 2	unit down	unit down	EVENTS	no events	unit down	unit down	unit down
site 3	no events	no events	no events	no events	no events	no events	no events
site 4	EVENTS	no events	EVENTS	EVENTS	EVENTS	EVENTS	EVENTS
site 5	no events	no events	EVENTS	EVENTS	EVENTS	EVENTS	unit down
site 6	EVENTS	no events	EVENTS	EVENTS	EVENTS	EVENTS	EVENTS
site 7	UNIT PULLED FROM MONITORING STUDY ----------						
site 8	EVENTS	no events	EVENTS	no events	EVENTS	EVENTS	EVENTS
site 9	EVENTS	no events	EVENTS	no events	no events	EVENTS	EVENTS

raining — raining — windy — raining — windy — windy

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
	29-Oct-01	30-Oct-01	31-Oct-01				
RANGE A							
RANGE B							
RANGE C							
RANGE D		45 cal, 12g					
site 1		EVENTS					
site 2		unit down					
site 3		no events					
site 4		EVENTS					
site 5		unit down					
site 6		EVENTS					
site 7	UNIT PULLED FROM MONITORING STUDY ----------						
site 8		EVENTS					
site 9		EVENTS					

raining

AMMUNITION REPORT
23 MAY - 31 OCTOBER 2001

	RANGE	AMMO	DODIC	FIRED		MONITORING DATA
23 May 2001	A	5.56 BALL	A071	7000		YES
23 May 2001	B	5.56 BALL	A071	4000		YES
23 May 2001	C	5.56 BALL	A071	1500		YES
23 May 2001	D	.45 CAL BALL	A475	750		YES
23 May 2001	D	9MM BALL	A360	750		YES
24 May 2001	A	.22 CAL BALL	A093	100		YES
24 May 2001	A	12GA 00BK	A011	110		YES
24 May 2001	A	5.56 BALL	A071	620		YES
29 May 2001	D	9MM BALL	A360	900		
30 May 2001	A	12GA 00BK	A011	640		
30 May 2001	A	9MM BALL	A360	4800		
31 May 2001	D	9MM BALL	A360	900		
02 June 2001	A	5.56 BALL	A062	7000		YES
02 June 2001	A	7.62 BALL	A131	6981		YES
04 June 2001	D	.45 CAL BALL	A475	500		YES
06 June 2001	A	.45 CAL BALL	A475	1650		YES
06 June 2001	C	.45 CAL BALL	A475	1650		YES
07 June 2001	C	.45 CAL BALL	A475	1650		YES
08 June 2001	A	5.56 BALL	A071	200		YES
08 June 2001	B	5.56 BALL	A071	200		YES
12 June 2001	A	5.56 BALL	A071	3100		YES
13 June 2001	B	5.56 BALL	A071	3100		YES
14 June 2001	A	5.56 BALL	A071	750		YES
14 June 2001	B	5.56 BALL	A071	4500		YES
15 June 2001	A	5.56 BALL	A071	7250		YES
15 June 2001	B	5.56 BALL	A071	4500		YES
15 June 2001	C	5.56 BALL	A071	6500		YES
19 June 2001	A	5.56 BALL	A071	500		
19 June 2001	A	9MM BALL	A360	250		
20 June 2001	A	5.56 BALL	A071	500		
20 June 2001	A	9MM BALL	A360	250		
22 June 2001	A	5.56 BALL	A071	1200		YES
22 June 2001	A	9MM BALL	A360	1200		YES
27 June 2001	B	5.56 BALL	A071	2800		YES
30 June 2001	D	.45 CAL BALL	A475	300		YES
30 June 2001	D	9MM BALL	A360	150		YES
09 July 2001	C	12GA 00BK	A011	500		YES
09 July 2001	C	5.56 BALL	A071	720		YES
09 July 2001	D	9MM BALL	A360	600		YES
10 July 2001	C	12GA 00BK	A011	500		
10 July 2001	C	5.56 BALL	A071	720		

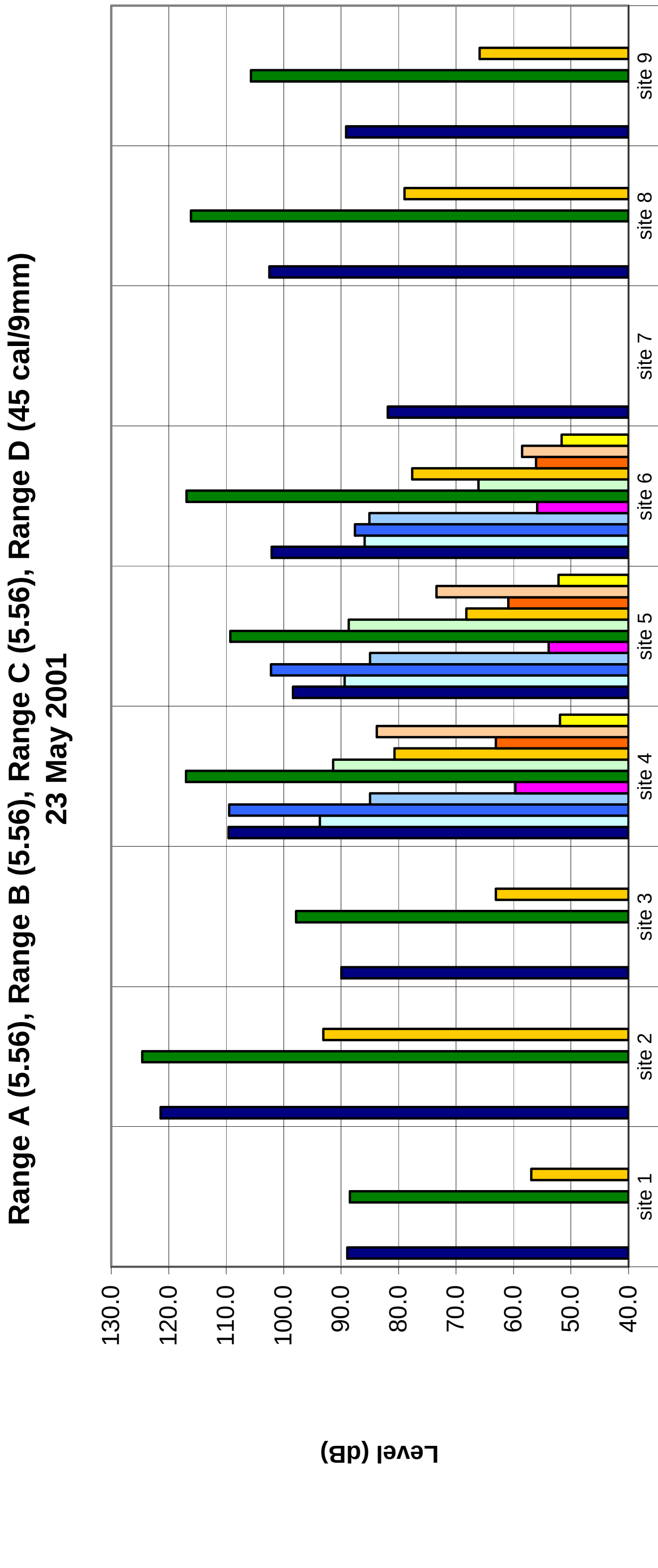
AMMUNITION REPORT
23 MAY - 31 OCTOBER 2001

	RANGE	AMMO	DODIC	FIRED		MONITORING DATA
10 July 2001	D	9MM BALL	A360	600		
13 July 2001	C	9MM BALL	A360	290		YES
14 July 2001	C	5.56 BALL	A071	500		YES
14 July 2001	D	9MM BALL	A360	500		YES
15 July 2001	C	5.56 BALL	A071	500		
17 July 2001	A	5.56 BALL	A071	6000		
20 July 2001	C	5.56 BALL	A071	3000		
21 July 2001	A	9MM BALL	A360	4000		YES
21 July 2001	C	5.56 BALL	A071	0		YES
22 July 2001	A	9MM BALL	A360	550		YES
22 July 2001	C	5.56 BALL	A071	550		YES
27 July 2001	A	12GA 00BK	A011	250		YES
27 July 2001	A	9MM BALL	A360	1500		YES
27 July 2001	C	9MM BALL	A360	1500		YES
28 July 2001	C	5.56 BALL	A071	5600		YES
29 July 2001	D	9MM BALL	A360	2900		
23 August 2001	A	5.56 BALL	A071	6660		YES
23 August 2001	B	5.56 BALL	A071	180		YES
23 August 2001	C	5.56 BALL	A071	60		YES
23 August 2001	C	9MM BALL	A360	1200		YES
24 August 2001	B	5.56 BALL	A071	4200		YES
26 August 2001	C	.45 CAL BALL	A475	600		
26 August 2001	C	12GA 00BK	A011	1300		
26 August 2001	C	9MM BALL	A360	2000		
27 August 2001	A	9MM BALL	A360	1500		
27 August 2001	C	9MM BALL	A360	1500		
28 August 2001	C	5.56 BALL	A071	5600		
29 August 2001	D	9MM BALL	A360	2900		
07 September 2001	A	5.56 BALL	A071	1200		YES
07 September 2001	B	5.56 BALL	A071	1200		YES
08 September 2001	A	9MM BALL	A360	1000		YES
08 September 2001	C	5.56 BALL	A071	3757		YES
08 September 2001	D	9MM BALL	A360	298		YES
13 September 2001	A	5.56 BALL	A071	900		YES
14 September 2001	B	5.56 BALL	A071	900		YES
19 September 2001	A	5.56 BALL	A071	6800		YES
19 September 2001	B	5.56 BALL	A071	2720		YES
21 September 2001	A	5.56 BALL	A071	600		YES
22 September 2001	A	.50 CAL PL	A601	610		YES
22 September 2001	A	7.62 BALL	A131	2000		YES
22 September 2001	C	5.56 BALL	A071	1576		YES

AMMUNITION REPORT
23 MAY - 31 OCTOBER 2001

	RANGE	AMMO	DODIC	FIRED	MONITORING DATA
22 September 2001	D	9MM BALL	A360	400	YES
28 September 2001	A	.22 CAL LR	A093	170	YES
28 September 2001	A	12 GA 00BK	A011	85	YES
28 September 2001	A	5.56 BALL	A071	340	YES
01 October 2001	C	.45 CAL BALL	A475	11000	
02 October 2001	C	.45 CAL BALL	A475	11000	YES
03 October 2001	C	.45 CAL BALL	A475	11000	YES
15 October 2001	A	5.56 BALL	A071	1000	YES
17 October 2001	C	.45 CAL BALL	A475	2800	YES
17 October 2001	C	12 GA 00BK	A011	400	YES
18 October 2001	C	.45 CAL BALL	A475	2800	YES
18 October 2001	C	12 GA 00BK	A011	400	YES
20 October 2001	C	5.56 BALL	A071	100080	YES
22 October 2001	A	9MM BALL	A360	2300	YES
23 October 2001	A	5.56 BALL	A071	300	
23 October 2001	A	9MM BALL	B519	1500	
23 October 2001	B	5.56 BALL	A071	300	
24 October 2001	A	5.56 BALL	A071	700	YES
24 October 2001	B	5.56 BALL	A071	700	YES
24 October 2001	C	.45 CAL BALL	A475	2800	YES
24 October 2001	C	12 GA 00BK	A131	400	YES
25 October 2001	C	.45 CAL BALL	A475	2800	YES
25 October 2001	C	12GA 00BK	A011	4000	YES
26 October 2001	A	5.56 BALL	A071	800	YES
26 October 2001	B	5.56 BALL	A071	1000	YES
27 October 2001	A	7.62 BALL	A131	3000	YES
27 October 2001	D	9MM BALL	A360	3000	YES
28 October 2001	B	5.56 BALL	A071	14657	YES
28 October 2001	C	5.56 BALL	A071	19000	YES
30 October 2001	D	.45 CAL BALL	A475	2100	YES
30 October 2001	D	12 GA 00BK	A011	210	YES
		TOTAL ROUND EXPENDITURE DURING MONITORING PERIOD		362334	
		ROUND EXPENDITURE CAPTURDED DURING MONITORING PERIOD		310874	

Appendix D
Daily Noise Data



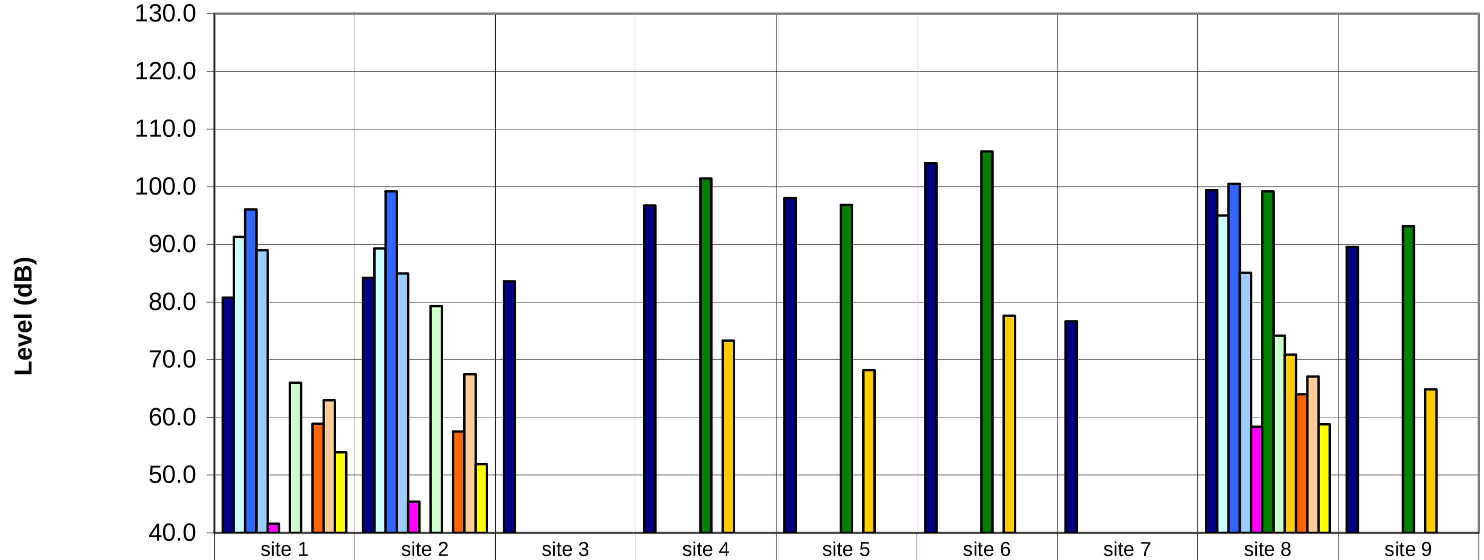
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	89.0	121.4	90.0	109.6	98.4	102.1	81.9	102.5	89.2
Monitoring Event Mean APeak				93.7	89.4	85.9			
Monitoring Event Max APeak				109.5	102.2	87.6			
Monitoring Event Min APeak				85.0	85.0	85.1			
LEQ (Monitoring Event & Amb.)				59.7	53.9	55.9			
SARNAM ASEL Total	88.5	124.6	97.8	117.0	109.3	116.9	-100.0	116.1	105.7
Monitoring ASEL Total				91.4	88.7	66.1			
SARNAM Event ASEL	56.9	93.1	63.1	80.7	68.2	77.6	-100.0	78.9	65.9
Monitoring Event Mean ASEL				63.1	60.9	56.1			
Monitoring Event Max ASEL				83.8	73.4	58.5			
Monitoring Event Min ASEL				51.9	52.2	51.6			

NOISE MONITORING DATA
Range A (5.56), Range B (5.56), Range C (5.56), Range D (45 cal/9mm)
23 May 2001
14000 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	Unit Down	Unit Down	Unit Down	372	404	9	Unit Down	Unit Down	Unit Down
Monitoring Event Mean APeak				93.7	89.4	85.9			
Standard Deviation Event APeak				4.6	3.6	0.9			
85-95				240	369	9			
95-105				127	35	0			
105-115				5	0	0			
115-125				0	0	0			
≥125				0	0	0			
Monitoring ASEL Total				91.4	88.7	66.1			
Monitoring Event Mean ASEL				63.1	60.9	56.1			
Standard Deviation Event ASEL				4	3.7	2.2			
40-50				0	0	0			
50-60				70	169	9			
60-70				288	227	0			
70-80				13	8	0			
80-90				1	0	0			
90-100				0	0	0			
>100				0	0	0			

TL=Trigger Level

Range A (5.56/12 guage/22 LR)
24 May 2001



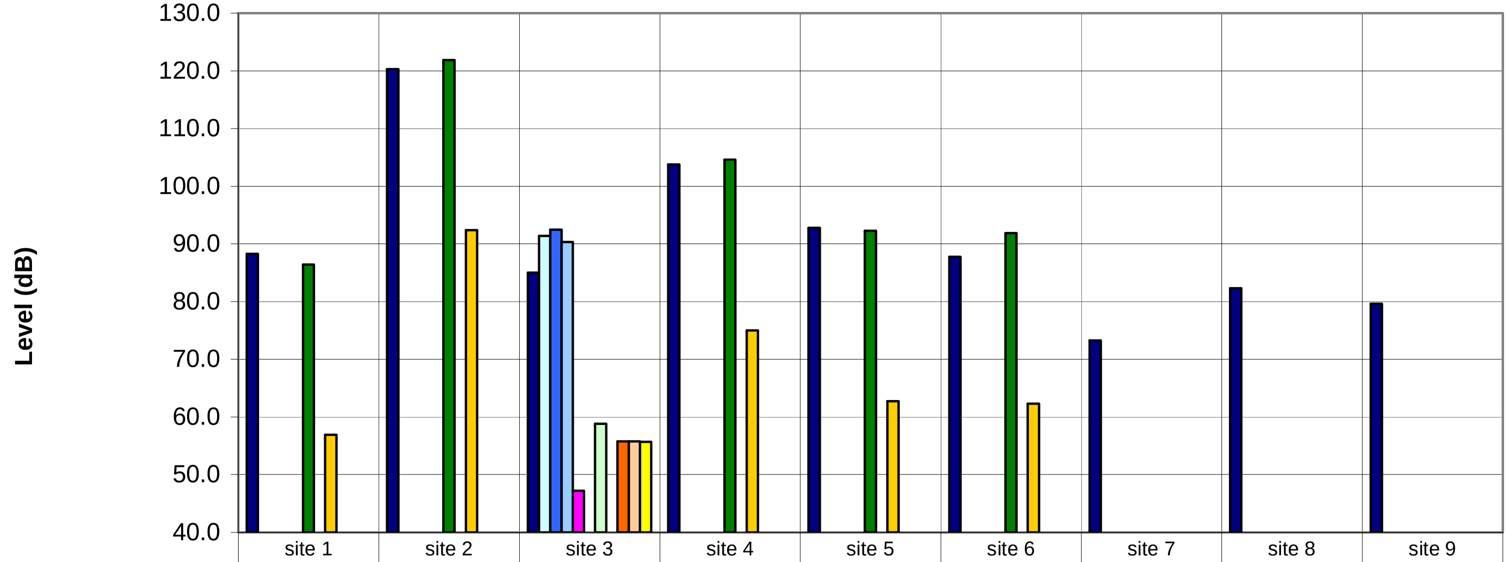
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	80.7	84.2	83.6	96.7	98.0	104.1	76.7	99.4	89.6
Monitoring Event Mean APeak	91.3	89.3						95.0	
Monitoring Event Max APeak	96.1	99.2						100.5	
Monitoring Event Min APeak	89.0	85.0						85.1	
LEQ (Monitoring Event & Amb.)	41.6	45.4						58.4	
SARNAM ASEL Tota	-100.0	-100.0	-100.0	101.4	96.9	106.1	-100.0	99.2	93.2
Monitoring ASEL Total	66.0	79.3						74.2	
SARNAM Event ASEL	-100.0	-100.0	-100.0	73.3	68.2	77.6	-100.0	70.9	64.9
Monitoring Event Mean ASEL	58.9	57.6						64.0	
Monitoring Event Max ASEL	63.0	67.5						67.1	
Monitoring Event Min ASEL	54.0	51.9						58.8	

NOISE MONITORING DATA
Range A (5.56/12 guage/22 LR)
24 May 2001
830 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	4	110	Unit Down	Unit Down	Unit Down	Unit Down	Unit Down	9	Unit Down
Monitoring Event Mean APeak	91.3	89.3						95	
Standard Deviation Event APeak	3.3	3.3						5	
85-95	3	102						3	
95-105	1	8						6	
105-115	0	0						0	
115-125	0	0						0	
≥125	0	0						0	
Monitoring ASEL Total	66	79.3						74.2	
Monitoring Event Mean ASEL	58.9	57.6						64	
Standard Deviation Event ASEL	3.9	3.1						2.7	
40-50	0	0						0	
50-60	2	83						1	
60-70	2	27						8	
70-80	0	0						0	
80-90	0	0						0	
90-100	0	0						0	
>100	0	0						0	

TL=Trigger Level

Range D (9mm)
29 May 2001



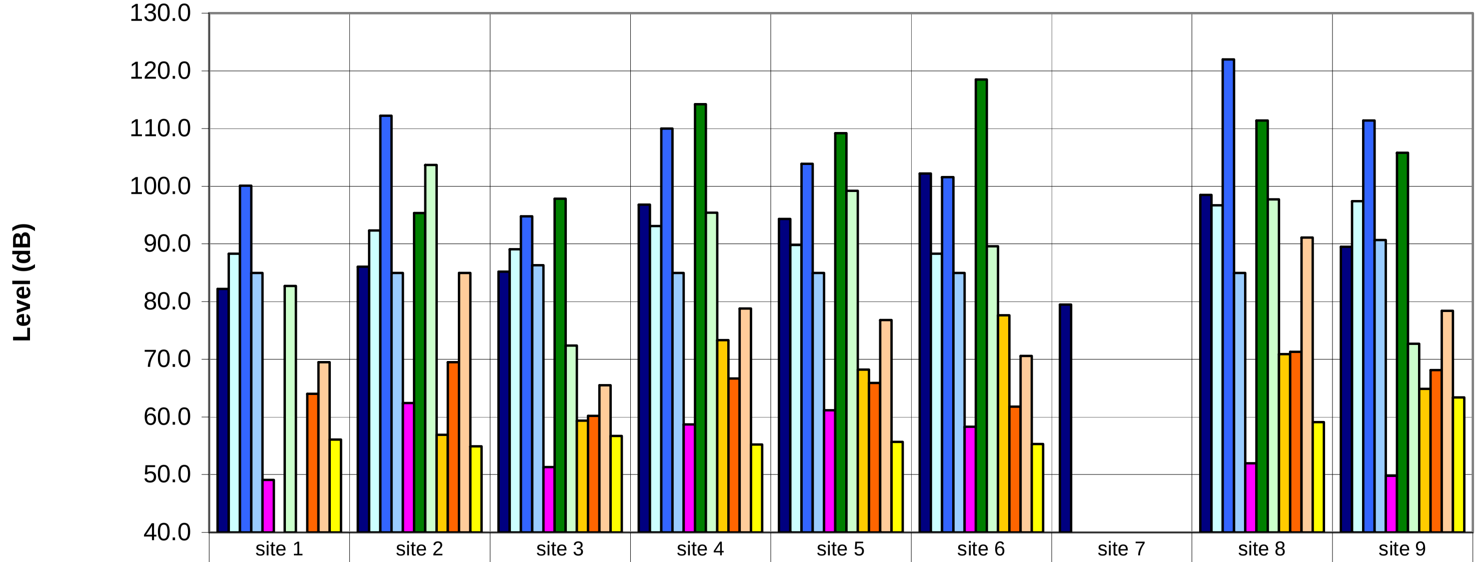
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	88.3	120.3	85.0	103.8	92.8	87.8	73.3	82.3	79.6
Monitoring Event Mean APeak			91.4						
Monitoring Event Max APeak			92.5						
Monitoring Event Min APeak			90.3						
LEQ (Monitoring Event & Amb.)			47.2						
SARNAM ASEL Total	86.4	121.9	-100.0	104.6	92.3	91.9	-100.0	-100.0	-100.0
Monitoring ASEL Total			58.8						
SARNAM Event ASEL	56.9	92.4	-100.0	75.0	62.7	62.3	-100.0	-100.0	-100.0
Monitoring Event Mean ASEL			55.8						
Monitoring Event Max ASEL			55.8						
Monitoring Event Min ASEL			55.7						

NOISE MONITORING DATA
Range D (9mm)
29 May 2001
900 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	Unit Down	Unit Down	2	Unit Down	Unit Down	Unit Down	Unit Down	Unit Down	Unit Down
Monitoring Event Mean APeak			91.4						
Standard Deviation Event APeak			1.5						
85-95			2						
95-105			0						
105-115			0						
115-125			0						
≥125			0						
Monitoring ASEL Total			58.8						
Monitoring Event Mean ASEL			55.8						
Standard Deviation Event ASEL			0.1						
40-50			0						
50-60			2						
60-70			0						
70-80			0						
80-90			0						
90-100			0						
>100			0						

TL=Trigger Level

Range A (5.56/7.62)
02 June 2001



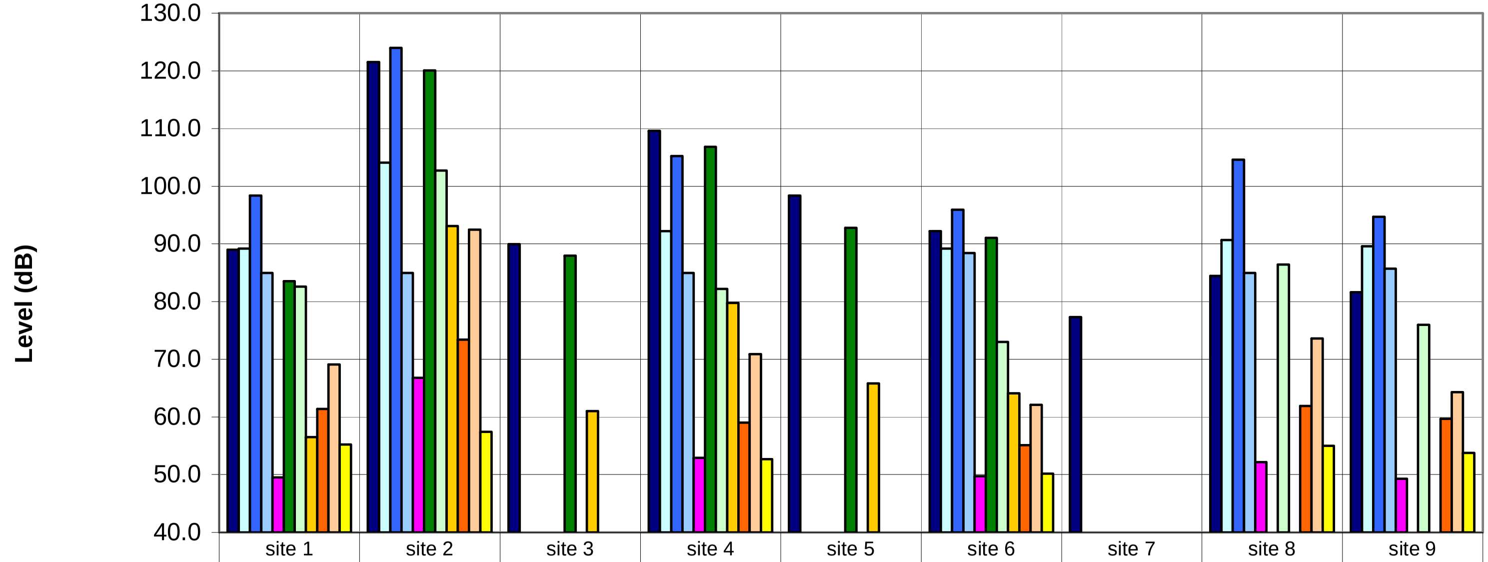
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	82.2	86.1	85.2	96.8	94.3	102.2	79.5	98.5	89.5
Monitoring Event Mean APeak	88.3	92.3	89.1	93.1	89.8	88.3		96.7	97.4
Monitoring Event Max APeak	100.1	112.2	94.8	110.0	103.9	101.6		122.0	111.4
Monitoring Event Min APeak	85.0	85.0	86.3	85.0	85.0	85.0		85.0	90.7
LEQ (Monitoring Event & Amb.)	49.1	62.4	51.3	58.7	61.2	58.3		52.0	49.8
SARNAM ASEL Total	-100.0	95.4	97.8	114.2	109.2	118.5	-100.0	111.4	105.8
Monitoring ASEL Total	82.7	103.7	72.4	95.4	99.2	89.6		97.7	72.7
SARNAM Event ASEL	-100.0	56.9	59.4	73.3	68.2	77.6	-100.0	70.9	64.9
Monitoring Event Mean ASEL	64.0	69.5	60.2	66.7	65.9	61.8		71.3	68.1
Monitoring Event Max ASEL	69.5	85.0	65.5	78.8	76.8	70.6		91.1	78.4
Monitoring Event Min ASEL	56.1	54.9	56.7	55.2	55.7	55.3		59.1	63.4

NOISE MONITORING DATA
Range A (5.56/7.62)
02 June 2001
13981 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	60	1660	14	512	1640	498	<TL	90	7
Monitoring Event Mean APeak	88.3	92.3	89.1	93.1	89.8	88.3		96.7	97.4
Standard Deviation Event APeak	3.2	4.9	2.4	4.3	3.5	2.8		10	7.8
85-95	57	1223	14	353	1497	485		49	5
95-105	3	406	0	155	143	13		23	0
105-115	0	31	0	4	0	0		9	2
115-125	0	0	0	0	0	0		9	0
≥125	0	0	0	0	0	0		0	0
Monitoring ASEL Total	82.7	103.7	72.4	95.4	99.2	89.6		97.7	72.7
Monitoring Event Mean ASEL	64	69.5	60.2	66.7	65.9	61.8		71.3	68.1
Standard Deviation Event ASEL	3	4	2.6	3.8	3.2	2.6		6.7	5.7
40-50	0	0	0	0	0	0		0	0
50-60	7	11	8	22	43	112		1	0
60-70	53	922	6	401	1423	383		44	5
70-80	0	716	0	89	174	3		33	2
80-90	0	11	0	0	0	0		11	0
90-100	0	0	0	0	0	0		1	0
>100	0	0	0	0	0	0		0	0

TL=Trigger Level

Range D (45 cal)
04 June 2001

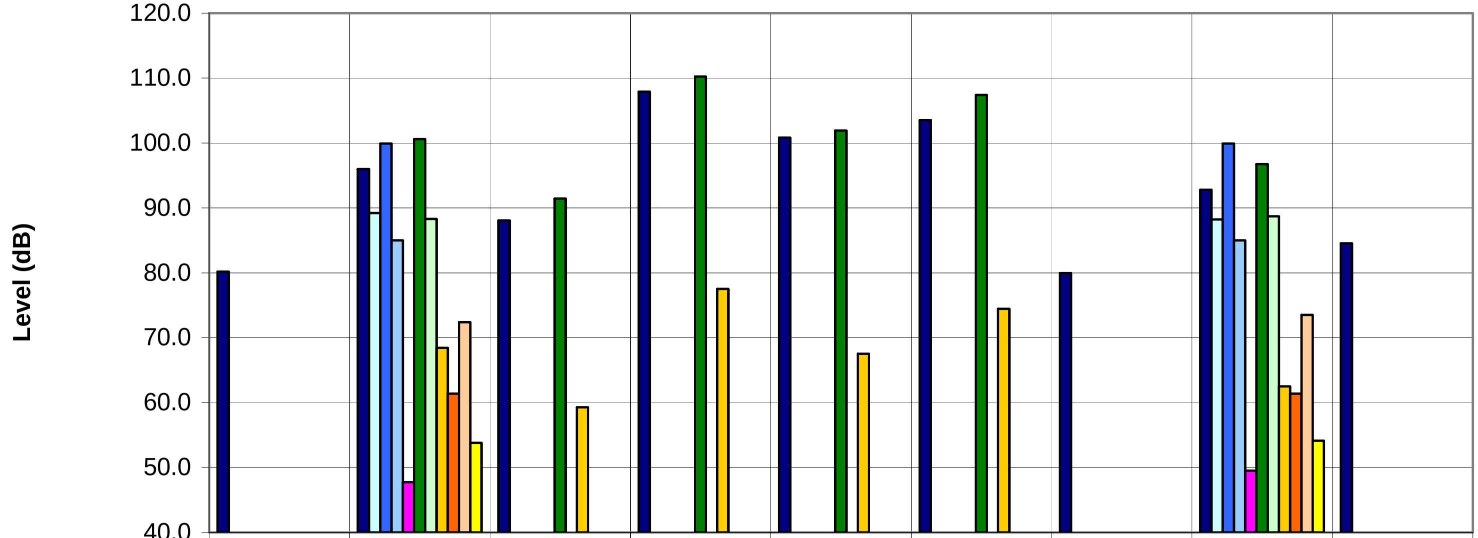


	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	89.0	121.5	90.0	109.6	98.4	92.2	77.3	84.5	81.6
Monitoring Event Mean APeak	89.2	104.1		92.2		89.2		90.7	89.6
Monitoring Event Max APeak	98.4	124.0		105.2		95.9		104.6	94.7
Monitoring Event Min APeak	85.0	85.0		85.0		88.4		85.0	85.7
LEQ (Monitoring Event & Amb.)	49.5	66.8		52.9		49.7		52.2	49.3
SARNAM ASEL Total	83.5	120.1	88.0	106.8	92.8	91.0	-100.0	-100.0	-100.0
Monitoring ASEL Total	82.6	102.7		82.2		73.0		86.4	76.0
SARNAM Event ASEL	56.5	93.1	61.0	79.8	65.8	64.1	-100.0	-100.0	-100.0
Monitoring Event Mean ASEL	61.4	73.4		59.0		55.1		61.9	59.7
Monitoring Event Max ASEL	69.1	92.5		70.9		62.1		73.6	64.3
Monitoring Event Min ASEL	55.2	57.4		52.7		50.2		55.0	53.8

NOISE MONITORING DATA
Range D (45 cal)
04 June 2001
500 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	94	316		143		48	<TL	197	35
Monitoring Event Mean APeak	89.2	104.1		92.2		89.2		90.7	89.6
Standard Deviation Event APeak	3.5	7.4		4.6		3		4.1	2.1
85-95	86	41		102		45		161	35
95-105	8	130		40		3		36	0
105-115	0	123		1		0		0	0
115-125	0	22		0		0		0	0
≥125	0	0		0		0		0	0
Monitoring ASEL Total	82.6	102.7		82.2		73		86.4	76
Monitoring Event Mean ASEL	61.4	73.4		59		55.1		61.9	59.7
Standard Deviation Event ASEL	3.5	5.8		3.5		2.9		3.5	2.9
40-50	0	0		0		0		0	0
50-60	32	5		94		43		64	17
60-70	62	81		48		5		128	18
70-80	0	190		1		0		5	0
80-90	0	37		0		0		0	0
90-100	0	3		0		0		0	0
>100	0	0		0		0		0	0

Range A (45 cal), Range C (45 cal)
06 June 2001



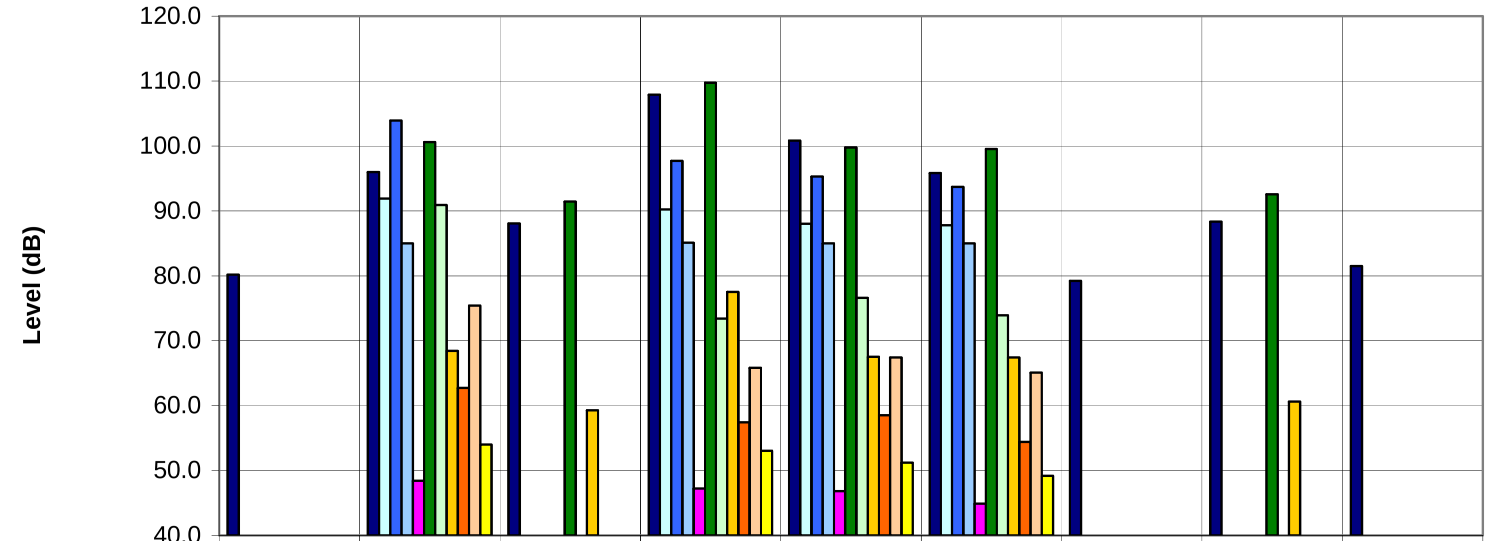
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	80.2	96.0	88.1	107.9	100.8	103.5	79.9	92.8	84.6
Monitoring Event Mean APeak		89.2						88.2	
Monitoring Event Max APeak		99.9						99.9	
Monitoring Event Min APeak		85.0						85.0	
LEQ (Monitoring Event & Amb.)		47.7						49.5	
SARNAM ASEL Total	-100.0	100.6	91.5	110.2	101.9	107.4	-100.0	96.7	-100.0
Monitoring ASEL Total		88.3						88.7	
SARNAM Event ASEL	-100.0	68.4	59.3	77.5	67.5	74.4	-100.0	62.5	
Monitoring Event Mean ASEL		61.4						61.4	
Monitoring Event Max ASEL		72.4						73.5	
Monitoring Event Min ASEL		53.8						54.1	

NOISE MONITORING DATA
Range A (45 cal), Range C (45 cal)
06 June 2001
3300 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	servicing unit	377	servicing unit	servicing unit	servicing unit	servicing unit	servicing unit	330	servicing unit
Monitoring Event Mean APeak		89.2						88.2	
Standard Deviation Event APeak		3.5						2.8	
85-95		345						321	
95-105		32						9	
105-115		0						0	
115-125		0						0	
≥125		0						0	
Monitoring ASEL Total		88.3						88.7	
Monitoring Event Mean ASEL		61.4						61.3	
Standard Deviation Event ASEL		3						4	
40-50		0						0	
50-60		126						144	
60-70		247						176	
70-80		4						10	
80-90		0						0	
90-100		0						0	
>100		0						0	

TL=Trigger Level

Range C (45 cal)
07 June 2001



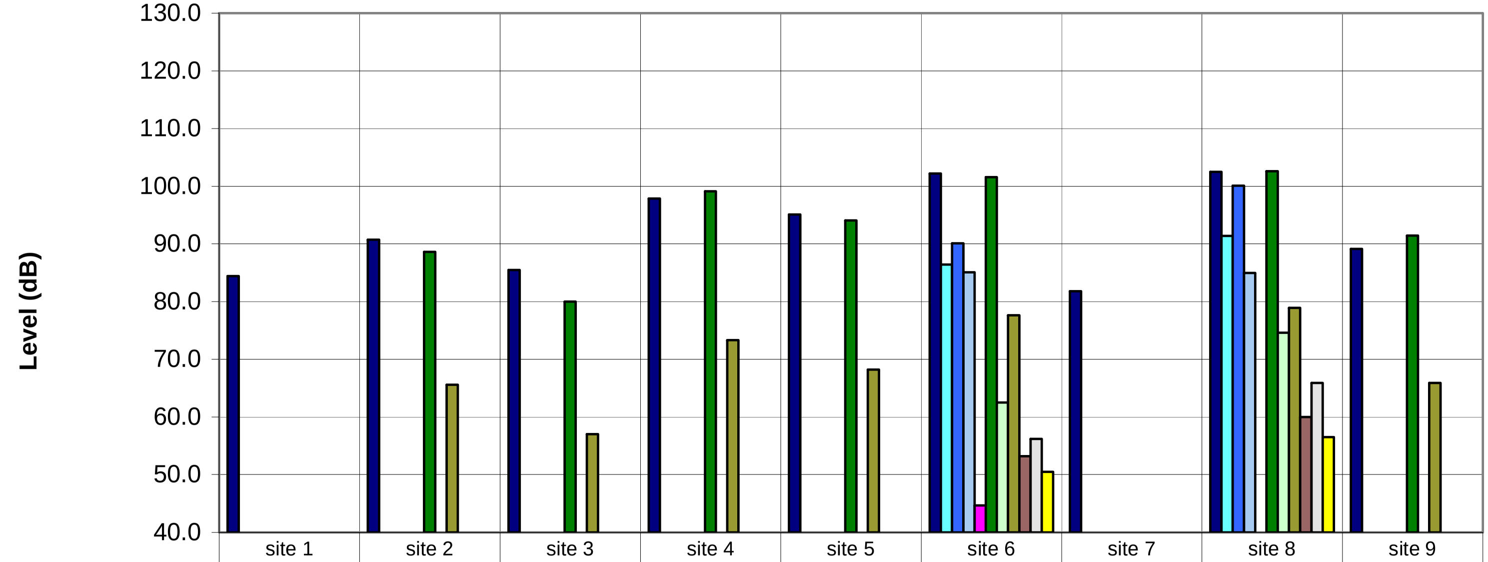
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	80.2	96.0	88.1	107.9	100.8	95.8	79.2	88.4	81.5
Monitoring Event Mean APeak		91.9		90.2	88.0	87.8			
Monitoring Event Max APeak		103.9		97.7	95.3	93.7			
Monitoring Event Min APeak		85.0		85.1	85.0	85.0			
LEQ (Monitoring Event & Amb.)		48.4		47.2	46.8	44.9			
SARNAM ASEL Total	-100.0	100.6	91.5	109.7	99.7	99.5	-100.0	92.5	-100.0
Monitoring ASEL Total		90.9		73.4	76.6	73.9			
SARNAM Event ASEL	-100.0	68.4	59.3	77.5	67.5	67.4	-100.0	60.6	-100.0
Monitoring Event Mean ASEL		62.7		57.4	58.5	54.4			
Monitoring Event Max ASEL		75.4		65.8	67.4	65.1			
Monitoring Event Min ASEL		54.0		53.0	51.2	49.2			

NOISE MONITORING DATA
Range C (45 cal)
07 June 2001
1650 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	<TL	404	No Files	31	46	67	<TL	<TL	Unit Down
Monitoring Event Mean APeak		91.9		90.2	88	87.8			
Standard Deviation Event APeak		4.7		3.1	2.5	2			
85-95		294		28	45	67			
95-105		110		3	1	0			
105-115		0		0	0	0			
115-125		0		0	0	0			
≥125		0		0	0	0			
Monitoring ASEL Total		90.9		73.4	76.6	73.9			
Monitoring Event Mean ASEL		62.7		57.4	58.5	54.4			
Standard Deviation Event ASEL		4		3	3.4	2.7			
40-50		0		0	0	1			
50-60		116		25	31	63			
60-70		269		6	15	3			
70-80		19		0	0	0			
80-90		0		0	0	0			
90-100		0		0	0	0			
>100		0		0	0	0			

TL=Trigger Level

Range A (5.56), Range B (5.56)
08 June 2001



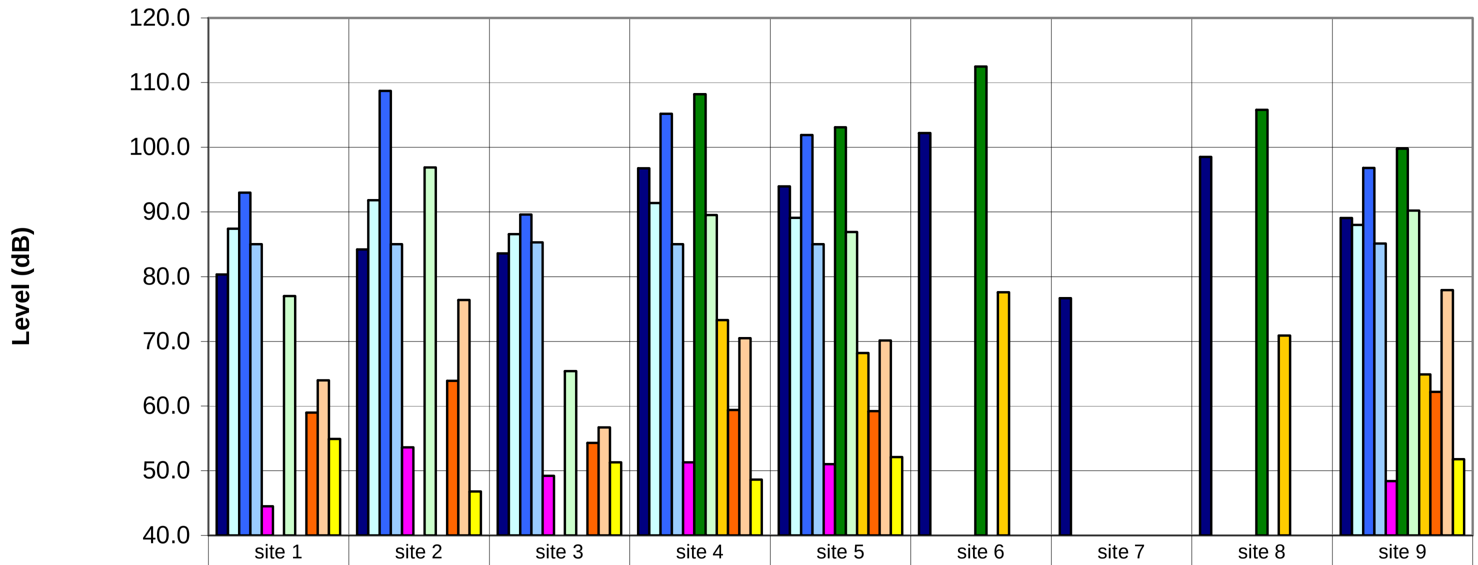
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	84.4	90.7	85.5	97.9	95.1	102.2	81.8	102.5	89.2
Monitoring Event Mean APeak						86.4		91.4	
Monitoring Event Max APeak						90.1		100.1	
Monitoring Event Min APeak						85.1		85.0	
LEQ (Monitoring Event & Amb.)						44.7			
SARNAM ASEL Total	-100.0	88.6	80.0	99.1	94.1	101.6	-100.0	102.6	91.5
Monitoring ASEL Total						62.5		74.6	
SARNAM Event ASEL	-100.0	65.6	57.0	73.3	68.2	77.6	-100.0	78.9	65.9
Monitoring Event Mean ASEL						53.2		60.0	
Monitoring Event Max ASEL						56.2		65.9	
Monitoring Event Min ASEL						50.5		56.5	

NOISE MONITORING DATA
Range A (5.56), Range B (5.56)
08 June 2001
400 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	<TL	<TL	No Files	<TL	<TL	8	<TL	25	Unit Down
Monitoring Event Mean APeak						86.4		91.4	
Standard Deviation Event APeak						1.7		4.3	
85-95						8		19	
95-105						0		6	
105-115						0		0	
115-125						0		0	
≥125						0		0	
Monitoring ASEL Total						62.5		74.6	
Monitoring Event Mean ASEL						53.2		60	
Standard Deviation Event ASEL						1.8		2.3	
40-50						0		0	
50-60						8		13	
60-70						0		12	
70-80						0		0	
80-90						0		0	
90-100						0		0	
>100						0		0	

TL=Trigger Level

Range A (5.56)
12 June 2001



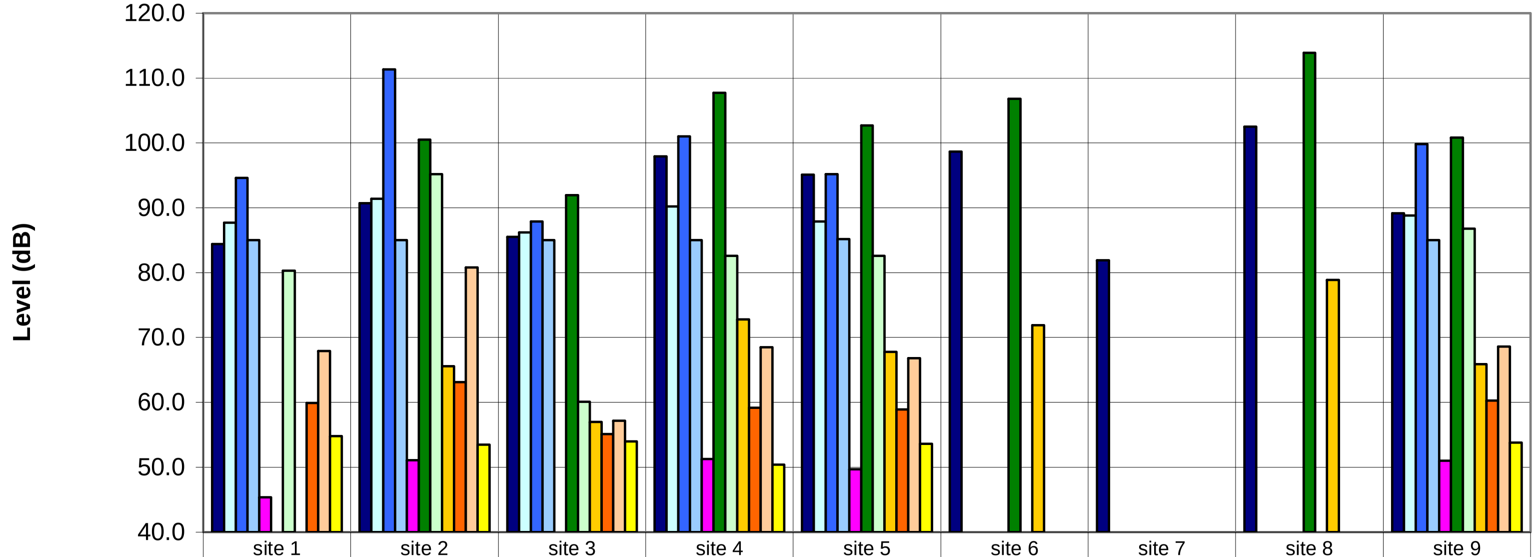
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	80.3	84.2	83.6	96.7	94.0	102.2	76.7	98.5	89.1
Monitoring Event Mean APeak	87.4	91.8	86.6	91.4	89.1				88.0
Monitoring Event Max APeak	93.0	108.7	89.6	105.2	101.9				96.8
Monitoring Event Min APeak	85.0	85.0	85.3	85.0	85.0				85.1
LEQ (Monitoring Event & Amb.)	44.5	53.6	49.2	51.3	51.0				48.4
SARNAM ASEL Total	-100.0	-100.0	-100.0	108.2	103.1	112.5	-100.0	105.8	99.8
Monitoring ASEL Total	77.0	96.9	65.4	89.5	86.9				90.2
SARNAM Event ASEL	-100.0	-100.0	-100.0	73.3	68.2	77.6	-100.0	70.9	64.9
Monitoring Event Mean ASEL	59.0	63.9	54.3	59.4	59.2				62.2
Monitoring Event Max ASEL	64.0	76.4	56.7	70.5	70.1				77.9
Monitoring Event Min ASEL	54.9	46.8	51.3	48.6	52.1				51.8

NOISE MONITORING DATA
RANGE A (5.56)
12 June 2001
3100 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	54	1221	12	713	457	Unit Down	<TL	Unit Down	197
Monitoring Event Mean APeak	87.4	91.8	86.6	91.4	89.1				88
Standard Deviation Event APeak	2.1	4.6	1.3	4	3.1				2.5
85-95	54	929	12	580	433				193
95-105	0	284	0	132	24				4
105-115	0	8	0	1	0				0
115-125	0	0	0	0	0				0
≥125	0	0	0	0	0				0
Monitoring ASEL Total	77	96.9	65.4	89.5	86.9				90.2
Monitoring Event Mean ASEL	59	63.9	54.3	59.4	59.2				62.2
Standard Deviation Event ASEL	2.3	4	1.8	3.6	2.9				6
40-50	0	1	0	1	0				0
50-60	38	176	12	424	287				82
60-70	16	940	0	286	170				81
70-80	0	104	0	2	1				34
80-90	0	0	0	0	0				0
90-100	0	0	0	0	0				0
>100	0	0	0	0	0				0

TL=Trigger Level

Range B (5.56)
13 June 2001



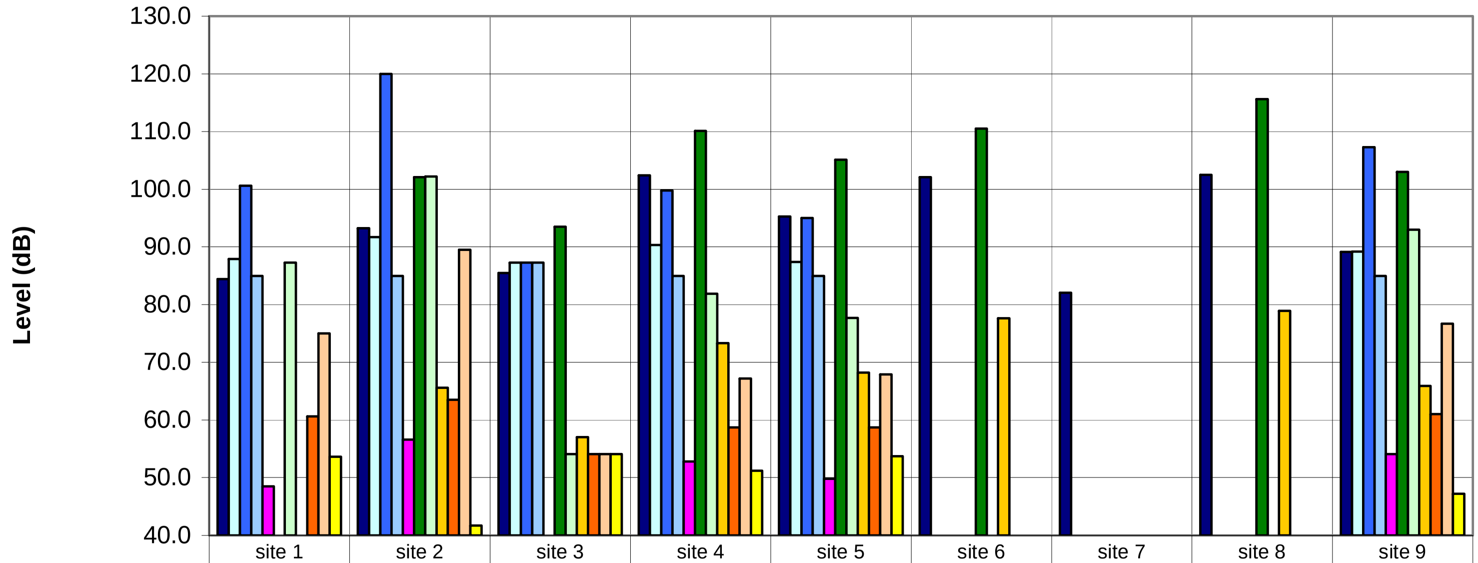
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	84.4	90.7	85.5	97.9	95.1	98.7	81.9	102.5	89.2
Monitoring Event Mean APeak	87.7	91.4	86.2	90.2	87.9				88.8
Monitoring Event Max APeak	94.6	111.3	87.9	101.0	95.2				99.8
Monitoring Event Min APeak	85.0	85.0	85.0	85.0	85.2				85.0
LEQ (Monitoring Event & Amb.)	45.4	51.1	0.0	51.3	49.7				51.0
SARNAM ASEL Total	-100.0	100.5	91.9	107.7	102.7	106.8	-100.0	113.9	100.8
Monitoring ASEL Total	80.3	95.2	60.1	82.6	82.6				86.8
SARNAM Event ASEL	-100.0	65.6	57.0	72.8	67.8	71.9	-100.0	78.9	65.9
Monitoring Event Mean ASEL	59.9	63.1	55.1	59.2	58.9				60.3
Monitoring Event Max ASEL	67.9	80.8	57.2	68.5	66.8				68.6
Monitoring Event Min ASEL	54.8	53.5	54.0	50.4	53.6				53.8

NOISE MONITORING DATA
RANGE B (5.56)
13 June 2001
3100 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	91	1025	3	156	53	Unit Down	Unit Down	Unit Down	353
Monitoring Event Mean APeak	8.7	91.4	86.2	90.2	87.9				88.8
Standard Deviation Event APeak	2.1	4.4	1.5	3.2	2.7				3
85-95	91	805	3	144	52				335
95-105	0	215	0	12	1				18
105-115	0	5	0	0	0				0
115-125	0	0	0	0	0				0
≥125	0	0	0	0	0				0
Monitoring ASEL Total	80.3	95.2	60.1	82.6	82.6				86.8
Monitoring Event Mean ASEL	59.9	63.1	55.1	59.2	58.9				60.3
Standard Deviation Event ASEL	2.5	3.8	1.8	3.5	2.7				2.9
40-50	0	0	0	0	0				0
50-60	48	220	3	98	34				171
60-70	43	757	0	58	19				182
70-80	0	47	0	0	0				0
80-90	0	1	0	0	0				0
90-100	0	0	0	0	0				0
>100	0	0	0	0	0				0

TL=Trigger Level

Range A (5.56), Range B (5.56)
14 June 2001



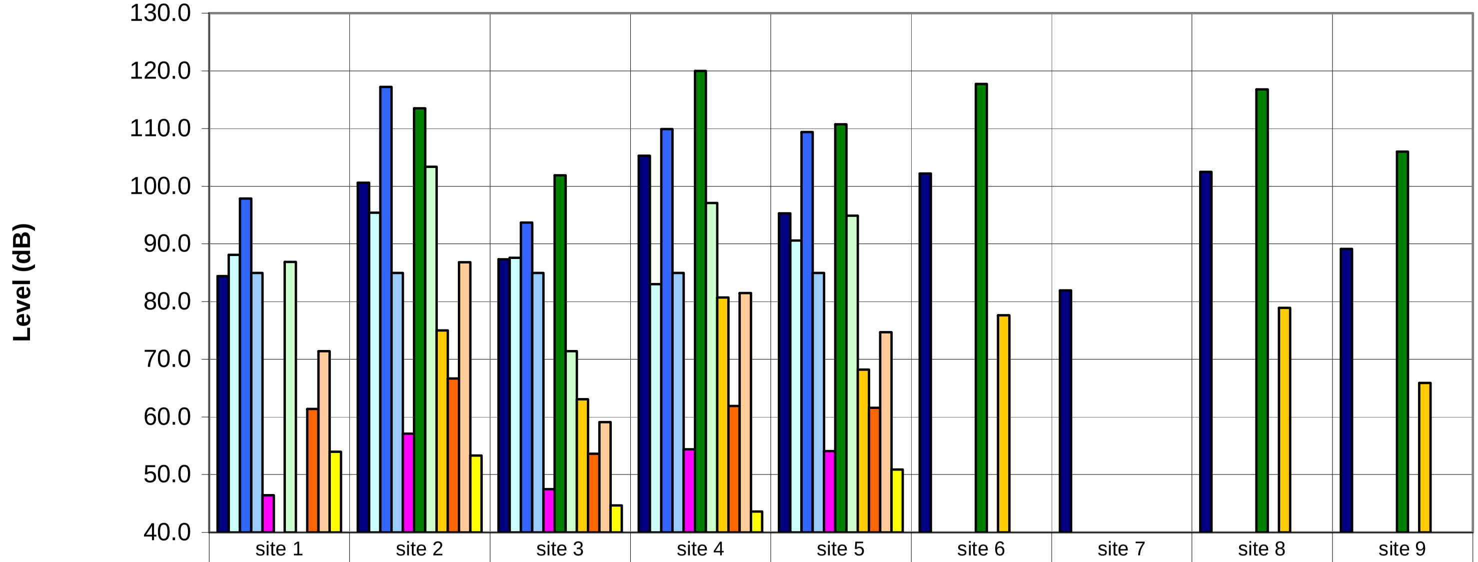
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	84.4	93.3	85.5	102.4	95.2	102.1	82.0	102.5	89.2
Monitoring Event Mean APeak	87.9	91.7	87.3	90.3	87.4				89.2
Monitoring Event Max APeak	100.6	120.0	87.3	99.8	95.0				107.3
Monitoring Event Min APeak	85.0	85.0	87.3	85.0	85.0				85.0
LEQ (Monitoring Event & Amb.)	48.5	56.6		52.8	49.8				54.1
SARNAM ASEL Total	-100.0	102.1	93.5	110.1	105.1	110.5	-100.0	115.6	103.0
Monitoring ASEL Total	87.3	102.2	54.1	81.9	77.7				93.0
SARNAM Event ASEL	-100.0	65.6	57.0	73.3	68.2	77.6	-100.0	78.9	65.9
Monitoring Event Mean ASEL	60.6	63.5	54.1	58.7	58.7				61.0
Monitoring Event Max ASEL	75.0	89.5	54.1	67.2	67.9				76.7
Monitoring Event Min ASEL	53.6	41.7	54.1	51.2	53.7				47.2

NOISE MONITORING DATA
Range A (5.56), Range B (5.56)
14 June 2001
5250 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	320	2429	1	156	56	Unit Down	<TL	Unit Down	1134
Monitoring Event Mean APeak	87.9	91.7	87.3	90.3	87.4				89.2
Standard Deviation Event APeak	2.7	5.5		3.5	2.1				3.4
85-95	313	1904	1	138	55				1057
95-105	7	437	0	18	1				76
105-115	0	77	0	0	0				1
115-125	0	11	0	0	0				0
≥125	0	0	0	0	0				0
Monitoring ASEL Total	87.3	102.2	54.1	81.9	77.7				93
Monitoring Event Mean ASEL	60.6	63.5	54.1	58.7	58.7				61
Standard Deviation Event ASEL	3.3	4.7		3.2	3.2				3.1
40-50	0	1	0	0	0				1
50-60	162	511	1	105	45				459
60-70	152	1724	0	51	11				665
70-80	6	168	0	0	0				9
80-90	0	25	0	0	0				0
90-100	0	0	0	0	0				0
>100	0	0	0	0	0				0

TL=Trigger Level

Range A (5.56), Range B (5.56), Range C (5.56)
15 June 2001



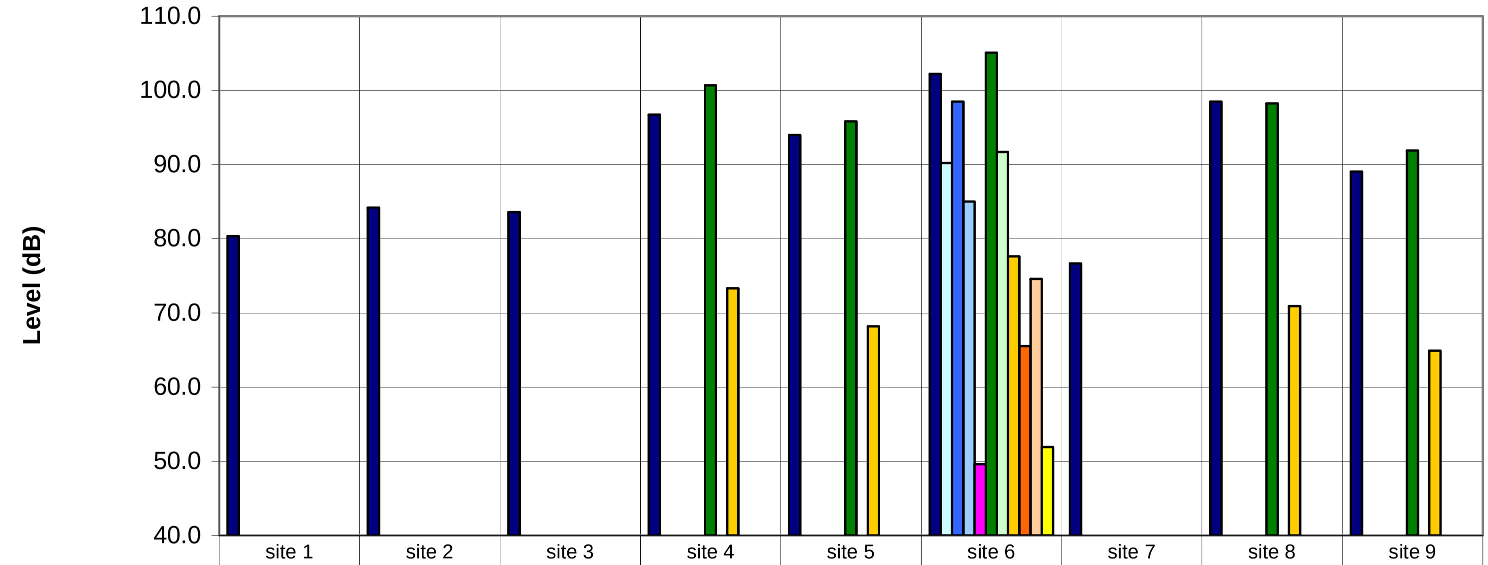
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	84.4	100.6	87.3	105.3	95.3	102.2	82.0	102.5	89.2
Monitoring Event Mean APeak	88.1	95.4	87.6	83.0	90.6				
Monitoring Event Max APeak	97.9	117.2	93.7	109.9	109.4				
Monitoring Event Min APeak	85.0	85.0	85.0	85.0	85.0				
LEQ (Monitoring Event & Amb.)	46.4	57.1	47.5	54.4	54.1				
SARNAM ASEL Total	-100.0	113.5	101.9	120.0	110.7	117.7	-100.0	116.8	106.0
Monitoring ASEL Total	86.9	103.4	71.4	97.1	94.9				
SARNAM Event ASEL	-100.0	75.0	63.1	80.7	68.2	77.6	-100.0	78.9	65.9
Monitoring Event Mean ASEL	61.4	66.7	53.6	61.9	61.6				
Monitoring Event Max ASEL	71.4	86.8	59.1	81.5	74.7				
Monitoring Event Min ASEL	54.0	53.3	44.7	43.6	50.9				

NOISE MONITORING DATA
Range A (5.56), Range B (5.56), Range C (5.56)
15 June 2001
18250 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	252	2107	50	1511	1400	Unit Down	Unit Down	Unit Down	Unit Down
Monitoring Event Mean APeak	88.1	95.4	87.6	93	90.6				
Standard Deviation Event APeak	2.5	6.5	2.1	4.8	4				
85-95	247	1083	50	1013	1193				
95-105	5	829	0	479	201				
105-115	0	187	0	19	6				
115-125	0	8	0	0	0				
≥125	0	0	0	0	0				
Monitoring ASEL Total	86.9	103.4	71.4	97.1	94.9				
Monitoring Event Mean ASEL	61.4	66.7	53.6	61.9	61.6				
Standard Deviation Event ASEL	3.5	5.1	2.8	4.9	3.8				
40-50	0	0	5	4	0				
50-60	101	175	45	548	496				
60-70	148	1453	0	875	873				
70-80	3	457	0	81	31				
80-90	0	22	0	3	0				
90-100	0	0	0	0	0				
>100	0	0	0	0	0				

TL=Trigger Level

Range A (5.56/9mm)
20 June 2001



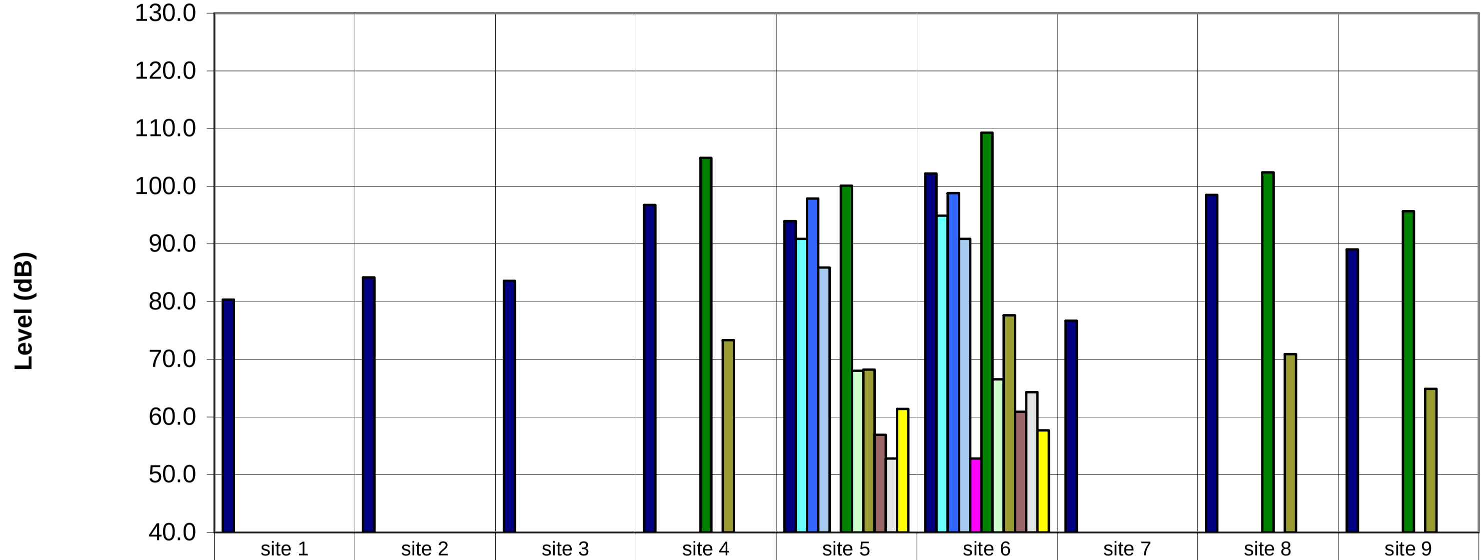
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	80.3	84.2	83.6	96.7	94.0	102.2	76.7	98.5	89.1
Monitoring Event Mean APeak						90.2			
Monitoring Event Max APeak						98.5			
Monitoring Event Min APeak						85.0			
LEQ (Monitoring Event & Amb.)						49.6			
SARNAM ASEL Total	-100.0	-100.0	-100.0	100.7	95.8	105.1	-100.0	98.2	91.9
Monitoring ASEL Total						91.7			
SARNAM Event ASEL	-100.0	-100.0	-100.0	73.3	68.2	77.6	-100.0	70.9	64.9
Monitoring Event Mean ASEL						65.5			
Monitoring Event Max ASEL						74.6			
Monitoring Event Min ASEL						51.9			

NOISE MONITORING DATA
Range A (5.56/9mm)
20 June 2001
750 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	<TL	No Files	No Files	No Files	No Files	295	<TL	Unit Down	Unit Down
Monitoring Event Mean APeak						90.2			
Standard Deviation Event APeak						3.2			
85-95						270			
95-105						25			
105-115						0			
115-125						0			
≥125						0			
Monitoring ASEL Total						91.7			
Monitoring Event Mean ASEL						65.5			
Standard Deviation Event ASEL						3.8			
40-50						0			
50-60						23			
60-70						240			
70-80						32			
80-90						0			
90-100						0			
>100						0			

TL=Trigger Level

Range A (5.56/9mm)
22 June 2001



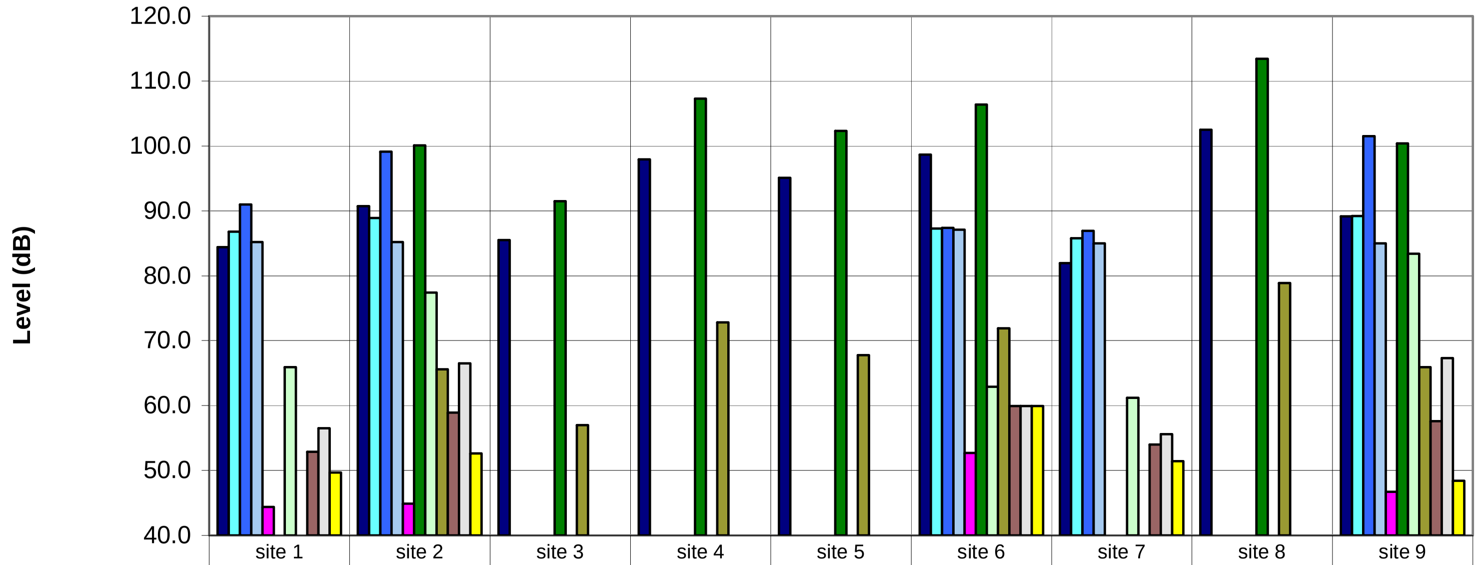
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	80.3	84.2	83.6	96.7	94.0	102.2	76.7	98.5	89.1
Monitoring Event Mean APeak					90.9	94.9			
Monitoring Event Max APeak					97.9	98.8			
Monitoring Event Min APeak					85.9	90.9			
LEQ (Monitoring Event & Amb.)						52.8			
SARNAM ASEL Total	-100.0	-100.0	-100.0	104.9	100.1	109.3	-100.0	102.4	95.7
Monitoring ASEL Total					68.0	66.5			
SARNAM Event ASEL	-100.0	-100.0	-100.0	73.3	68.2	77.6	-100.0	70.9	64.9
Monitoring Event Mean ASEL					56.9	60.9			
Monitoring Event Max ASEL					52.8	64.3			
Monitoring Event Min ASEL					61.4	57.7			

NOISE MONITORING DATA
Range A (5.56/9mm)
22 June 2001
2400 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	<TL	<TL	<TL	<TL	11	3	<TL	Unit Down	Unit Down
Monitoring Event Mean APeak					90.9	94.9			
Standard Deviation Event APeak					4	5.4			
85-95					9	1			
95-105					2	2			
105-115					0	0			
115-125					0	0			
≥125					0	0			
Monitoring ASEL Total					68	66.5			
Monitoring Event Mean ASEL					56.9	60.9			
Standard Deviation Event ASEL					1.5	3.3			
40-50					0	0			
50-60					9	1			
60-70					2	2			
70-80					0	0			
80-90					0	0			
90-100					0	0			
>100					0	0			

TL=Trigger Level

Range B (5.56)
27 June 2001



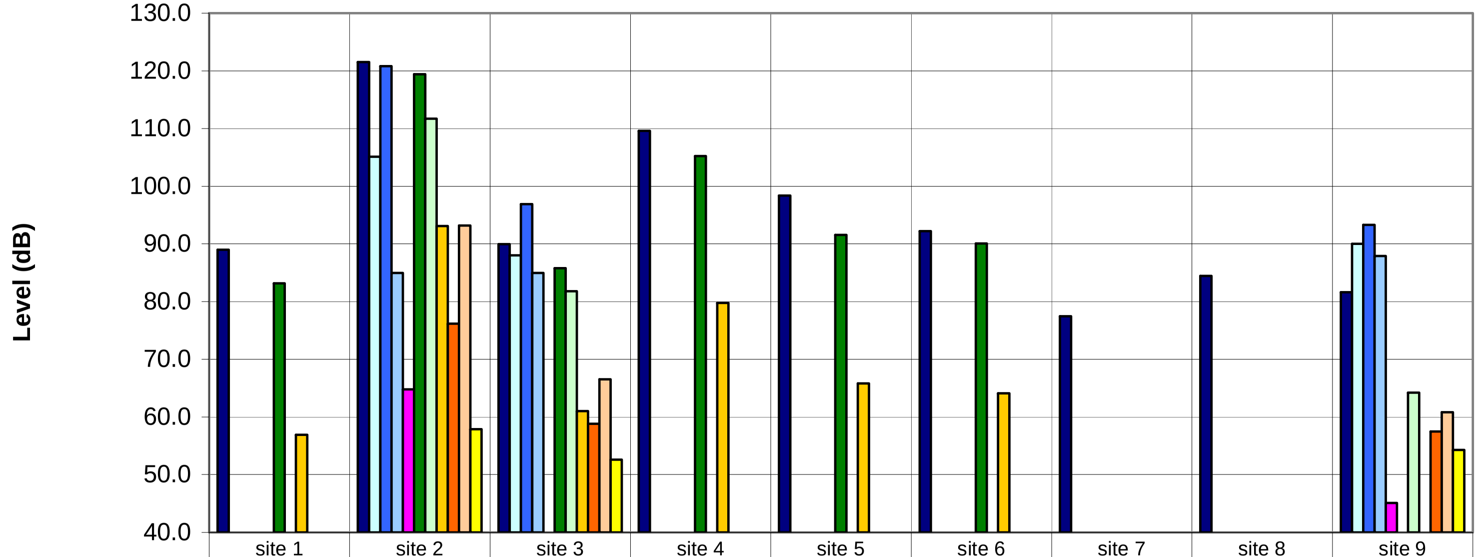
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	84.4	90.7	85.5	97.9	95.1	98.7	82.0	102.5	89.2
Monitoring Event Mean APeak	86.8	88.9				87.3	85.8		89.2
Monitoring Event Max APeak	91.0	99.1				87.4	86.9		101.5
Monitoring Event Min APeak	85.2	85.2				87.1	85.0		85.0
LEQ (Monitoring Event & Amb.)	44.4	44.9				52.7			46.7
SARNAM ASEL Total	-100.0	100.1	91.5	107.3	102.3	106.4	-100.0	113.4	100.4
Monitoring ASEL Total	65.9	77.4				62.9	61.2		83.4
SARNAM Event ASEL	-100.0	65.6	57.0	72.8	67.8	71.9	-100.0	78.9	65.9
Monitoring Event Mean ASEL	52.9	58.9				59.9	54.0		57.6
Monitoring Event Max ASEL	56.5	66.5				59.9	55.6		67.3
Monitoring Event Min ASEL	49.7	52.6				59.9	51.4		48.4

NOISE MONITORING DATA
Range B (5.56)
27 June 2001
2800 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	18	58	No Files	Unit Down	<TL	2	5	Unit Down	293
Monitoring Event Mean APeak	86.8	88.9				87.3	85.8		89.2
Standard Deviation Event APeak	1.8	3.3				0.2	0.8		3
85-95	18	53				2	5		277
95-105	0	5				0	0		16
105-115	0	0				0	0		0
115-125	0	0				0	0		0
≥125	0	0				0	0		0
Monitoring ASEL Total	65.9	77.4				62.9	61.2		83.4
Monitoring Event Mean ASEL	52.9	58.9				59.9	54		57.6
Standard Deviation Event ASEL	2	2.7				0	1.6		3
40-50	1	0				0	0		1
50-60	17	40				2	5		241
60-70	0	18				0	0		51
70-80	0	0				0	0		0
80-90	0	0				0	0		0
90-100	0	0				0	0		0
>100	0	0				0	0		0

TL=Trigger Level

Range D (45 cal/9mm)
30 June 2001



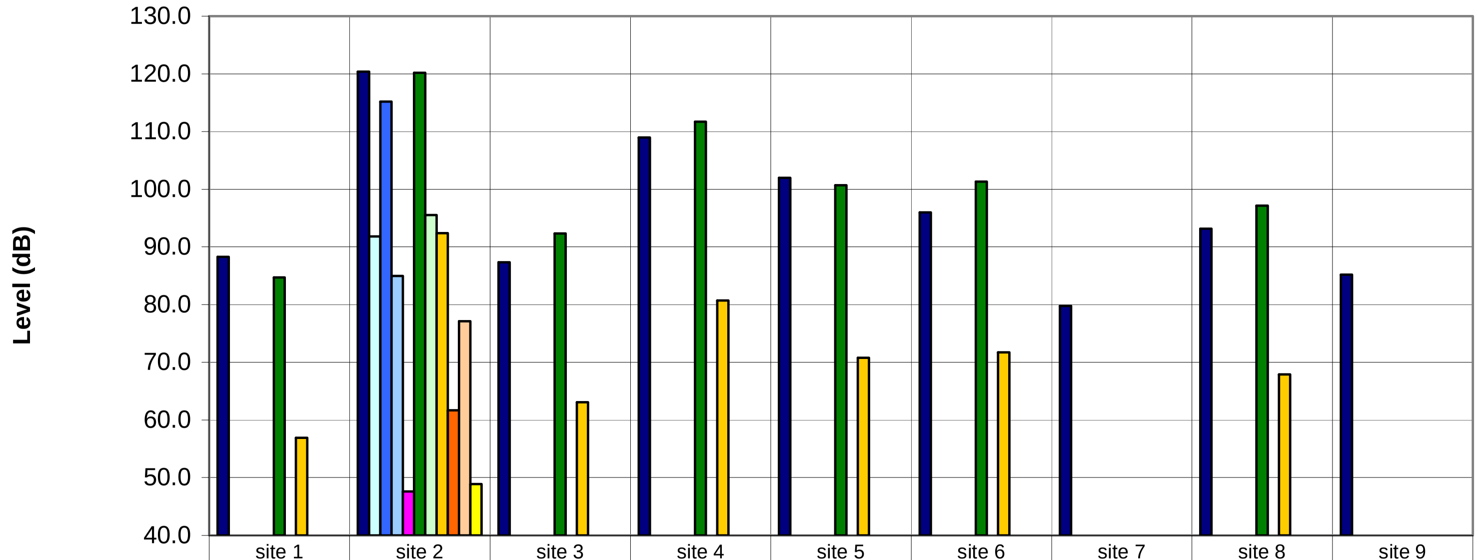
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	89.0	121.5	90.0	109.6	98.4	92.2	77.5	84.4	81.6
Monitoring Event Mean APeak		105.1	88.0						90.0
Monitoring Event Max APeak		120.8	96.9						93.3
Monitoring Event Min APeak		85.0	85.0						87.9
LEQ (Monitoring Event & Amb.)		64.8							45.1
SARNAM ASEL Total	83.2	119.4	85.8	105.2	91.5	90.1	-100.0	-100.0	-100.0
Monitoring ASEL Total		111.7	81.8						64.2
SARNAM Event ASEL	56.9	93.1	61.0	79.8	65.8	64.1	-100.0	-100.0	-100.0
Monitoring Event Mean ASEL		76.2	58.8						57.5
Monitoring Event Max ASEL		93.2	66.5						60.8
Monitoring Event Min ASEL		57.9	52.6						54.3

NOISE MONITORING DATA
Range D (45 cal/9mm)
30 June 2001
450 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	Unit Down	1854	191	Unit Down	<TL	<TL	<TL	Unit Down	4
Monitoring Event Mean APeak		105.1	88						90
Standard Deviation Event APeak		7.5	2.6						2.6
85-95		203	188						4
95-105		580	3						0
105-115		960	0						0
115-125		111	0						0
≥125		0	0						0
Monitoring ASEL Total		111.7	81.8						64.2
Monitoring Event Mean ASEL		76.2	58.1						57.5
Standard Deviation Event ASEL		5.4	2.8						2.9
40-50		0	0						0
50-60		6	145						3
60-70		265	46						1
70-80		1126	0						0
80-90		451	0						0
90-100		6	0						0
>100		0	0						0

TL=Trigger Level

Range C (12 Gauge/5.56), Range D (9mm)
09 July 2001



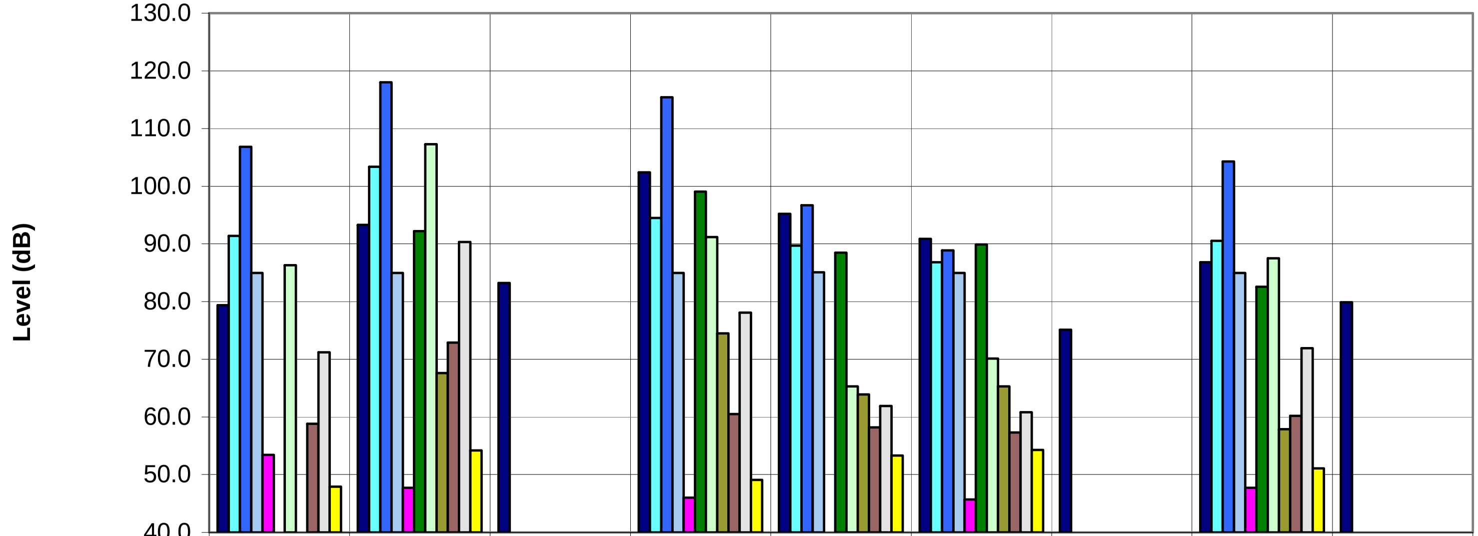
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	88.2	120.4	87.3	109.0	102.0	96.0	79.8	93.1	85.2
Monitoring Event Mean APeak		91.8							
Monitoring Event Max APeak		115.2							
Monitoring Event Min APeak		85.0							
LEQ (Monitoring Event & Amb.)		47.6							
SARNAM ASEL Total	84.7	120.2	92.3	111.7	100.7	101.3	-100.0	97.2	-100.0
Monitoring ASEL Total		95.5							
SARNAM Event ASEL	56.9	92.4	63.1	80.7	70.8	71.7	-100.0	67.9	-100.0
Monitoring Event Mean ASEL		61.7							
Monitoring Event Max ASEL		77.1							
Monitoring Event Min ASEL		48.9							

NOISE MONITORING DATA
Range C (12 gauge/5.56), Range D (9mm)
09 July 2001
1820 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	servicing unit	1439	servicing unit	servicing unit	servicing unit	servicing unit	servicing unit	servicing unit	servicing unit
Monitoring Event Mean APeak		91.8							
Standard Deviation Event APeak		5.1							
85-95		1110							
95-105		302							
105-115		26							
115-125		1							
≥125		0							
Monitoring ASEL Total		95.5							
Monitoring Event Mean ASEL		61.7							
Standard Deviation Event ASEL		4.2							
40-50		2							
50-60		502							
60-70		892							
70-80		43							
80-90		0							
90-100		0							
>100		0							

TL=Trigger Level

Range C (9mm)
13 July 2001



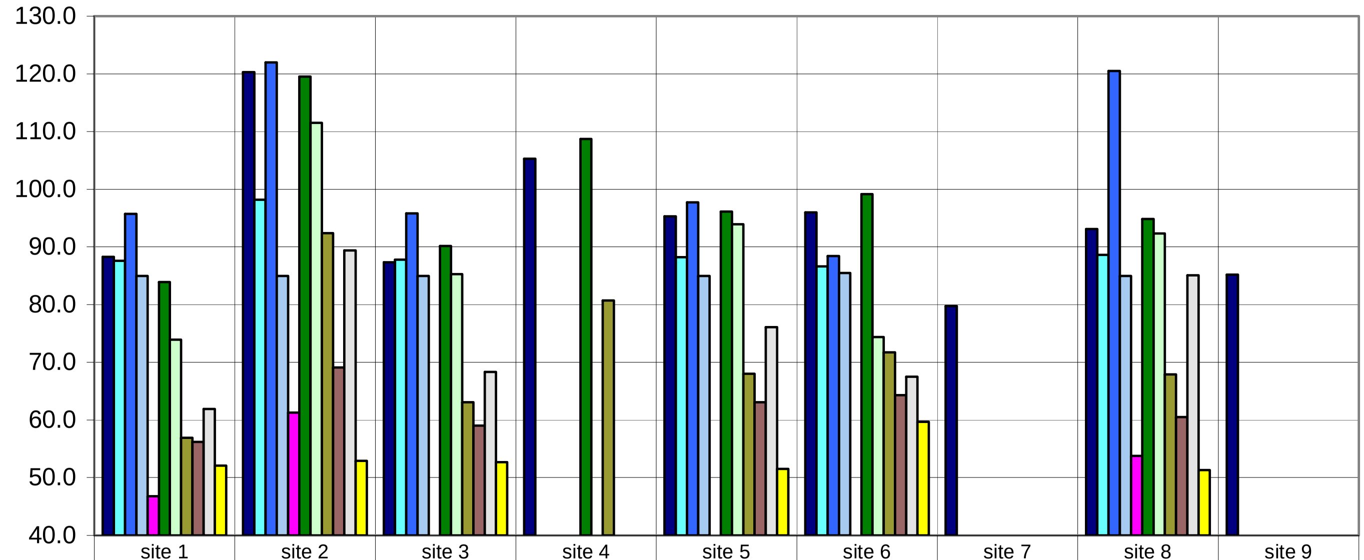
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	79.4	93.3	83.2	102.4	95.2	90.9	75.1	86.9	79.9
Monitoring Event Mean APeak	91.4	103.4		94.5	89.7	86.8		90.5	
Monitoring Event Max APeak	106.8	118.0		115.4	96.7	88.9		104.3	
Monitoring Event Min APeak	85.0	85.0		85.0	85.1	85.0		85.0	
LEQ (Monitoring Event & Amb.)	53.4	47.7		46.0		45.7		47.7	
SARNAM ASEL Total	-100.0	92.2	-100.0	99.1	88.5	89.9	-100.0	82.6	-100.0
Monitoring ASEL Total	86.3	107.3		91.2	65.3	70.1		87.5	
SARNAM Event ASEL	-100.0	67.6	-100.0	74.5	63.9	65.3	-100.0	57.9	-100.0
Monitoring Event Mean ASEL	58.8	72.9		60.5	58.2	57.3		60.2	
Monitoring Event Max ASEL	71.2	90.3		78.1	61.9	60.8		71.9	
Monitoring Event Min ASEL	47.9	54.2		49.1	53.3	54.3		51.1	

NOISE MONITORING DATA
Range C (9mm)
13 July 2001
290 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	333	735	<TL	511	4	17	<TL	352	No Files
Monitoring Event Mean APeak	91.4	103.4		94.5	89.7	86.8		90.5	
Standard Deviation Event APeak	4.2	10		5.8	5.1	1.3		3.7	
85-95	270	223		297	3	17		309	
95-105	61	84		103	1	0		43	
105-115	2	404		30	0	0		0	
115-125	0	24		1	0	0		0	
≥125	0	0		0	0	0		0	
Monitoring ASEL Total	86.3	107.3		91.2	65.3	70.1		87.5	
Monitoring Event Mean ASEL	58.8	72.9		60.5	58.2	57.3		60.2	
Standard Deviation Event ASEL	4.2	8.6		5.2	3.8	2		3.9	
40-50	1	0		4	0	0		0	
50-60	215	61		243	2	14		185	
60-70	114	222		238	2	3		164	
70-80	3	276		26	0	0		3	
80-90	0	175		0	0	0		0	
90-100	0	1		0	0	0		0	
>100	0	0		0	0	0		0	

TL=Trigger Level

Range C (5.56), Range D (9mm)
14 July 2001



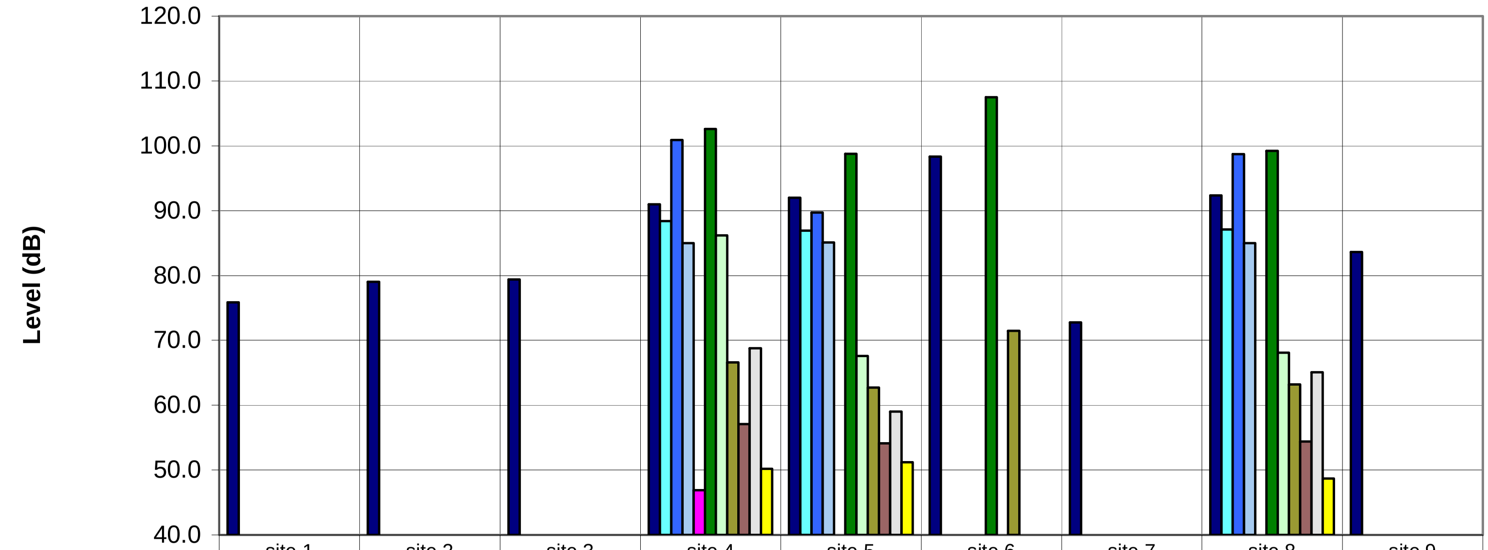
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	88.3	120.3	87.3	105.3	95.3	96.0	79.7	93.1	85.2
Monitoring Event Mean APeak	87.6	98.2	87.8		88.2	86.6		88.6	
Monitoring Event Max APeak	95.7	122.0	95.8		97.7	88.4		120.5	
Monitoring Event Min APeak	85.0	85.0	85.0		85.0	85.5		85.0	
LEQ (Monitoring Event & Amb.)	46.8	61.3						53.8	
SARNAM ASEL Total	83.9	119.5	90.2	108.7	96.2	99.1	-100.0	94.8	-100.0
Monitoring ASEL Total	73.9	111.5	85.3		93.9	74.4		92.3	
SARNAM Event ASEL	56.9	92.4	63.1	80.7	68.0	71.7	-100.0	67.9	-100.0
Monitoring Event Mean ASEL	56.2	69.1	59.0		63.1	64.3		60.5	
Monitoring Event Max ASEL	61.9	89.4	68.3		76.1	67.5		85.1	
Monitoring Event Min ASEL	52.1	52.9	52.7		51.5	59.7		51.3	

NOISE MONITORING DATA
Range C (5.56), Range D (9mm)
14 July 2001
1000 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	50	4730	343	Unit Down	787	9	<TL	439	<TL
Monitoring Event Mean APeak	87.6	98.2	87.8		88.2	86.6		88.6	
Standard Deviation Event APeak	2.4	9	2.4		2.5	1.1		4.7	
85-95	49	2064	341		764	9		404	
95-105	1	1412	2		13	0		28	
105-115	0	1118	0		0	0		4	
115-125	0	136	0		0	0		3	
≥125	0	0	0		0	0		0	
Monitoring ASEL Total	73.9	111.5	85.3		93.9	74.4		92.3	
Monitoring Event Mean ASEL	56.2	69.1	59		63.1	64.3		60.5	
Standard Deviation Event ASEL	2.4	7.1	2.9		4.2	2.3		4.8	
40-50	0	0	0		0	0		0	
50-60	45	442	220		215	8		247	
60-70	5	2293	123		550	1		176	
70-80	0	1609	0		22	0		13	
80-90	0	386	0		0	0		3	
90-100	0	0	0		0	0		0	
>100	0	0	0		0	0		0	

TL=Trigger Level

Range A (9mm)
21 July 2001



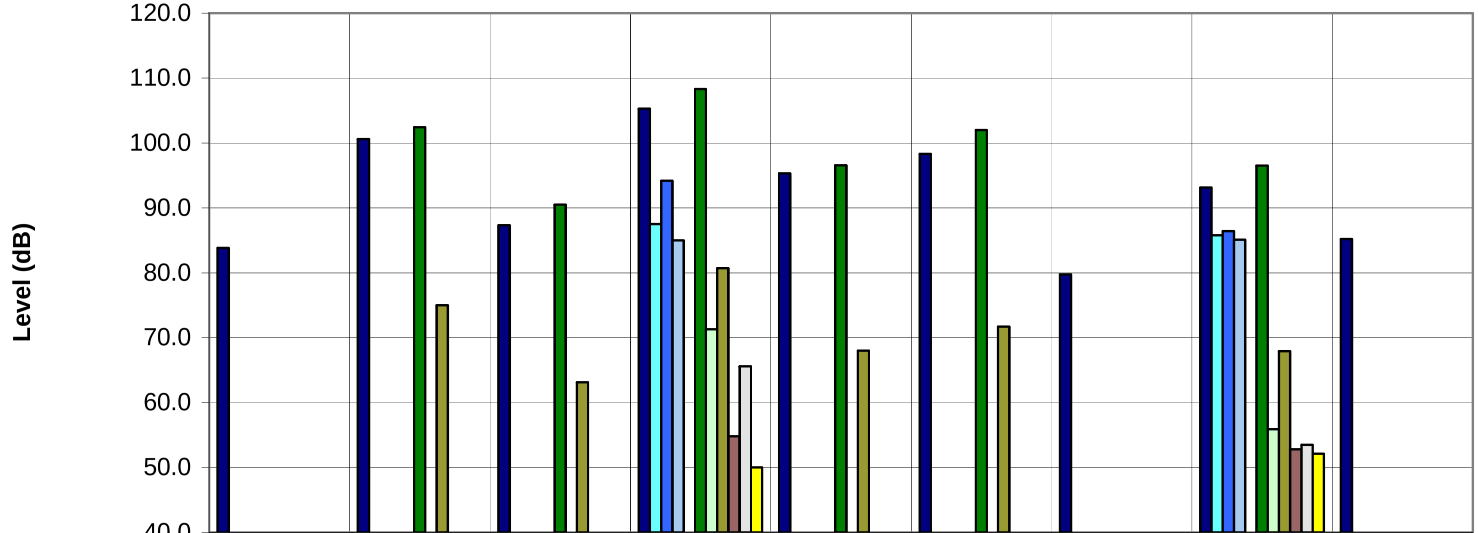
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	75.9	79.0	79.4	91.0	92.0	98.3	72.8	92.4	83.6
Monitoring Event Mean APeak				88.4	86.9			87.1	
Monitoring Event Max APeak				100.9	89.7			98.7	
Monitoring Event Min APeak				85.0	85.1			85.0	
LEQ (Monitoring Event & Amb.)				46.9					
SARNAM ASEL Total	-100.0	-100.0	-100.0	102.6	98.8	107.5	-100.0	99.2	-100.0
Monitoring ASEL Total				86.2	67.6			68.1	
SARNAM Event ASEL	-100.0	-100.0	-100.0	66.6	62.7	71.5	-100.0	63.2	-100.0
Monitoring Event Mean ASEL				57.1	54.1			54.4	
Monitoring Event Max ASEL				68.8	59.0			65.1	
Monitoring Event Min ASEL				50.2	51.2			48.7	

NOISE MONITORING DATA
Range D (9mm)
21 July 2001
4000 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	Unit Down	Unit Down	Unit Down	645	20	<TL	<TL	14	Unit Down
Monitoring Event Mean APeak				88.4	86.9			87.1	
Standard Deviation Event APeak				2.9	1.5			3.6	
85-95				623	20			13	
95-105				22	0			1	
105-115				0	0			0	
115-125				0	0			0	
≥125				0	0			0	
Monitoring ASEL Total				86.2	67.6			68.1	
Monitoring Event Mean ASEL				57.1	54.1			54.4	
Standard Deviation Event ASEL				2.7	1.9			3.6	
40-50				0	0			1	
50-60				551	20			12	
60-70				94	0			1	
70-80				0	0			0	
80-90				0	0			0	
90-100				0	0			0	
>100				0	0			0	

TL=Trigger Level

Range A (9mm), Range C (5.56)
22 July 2001



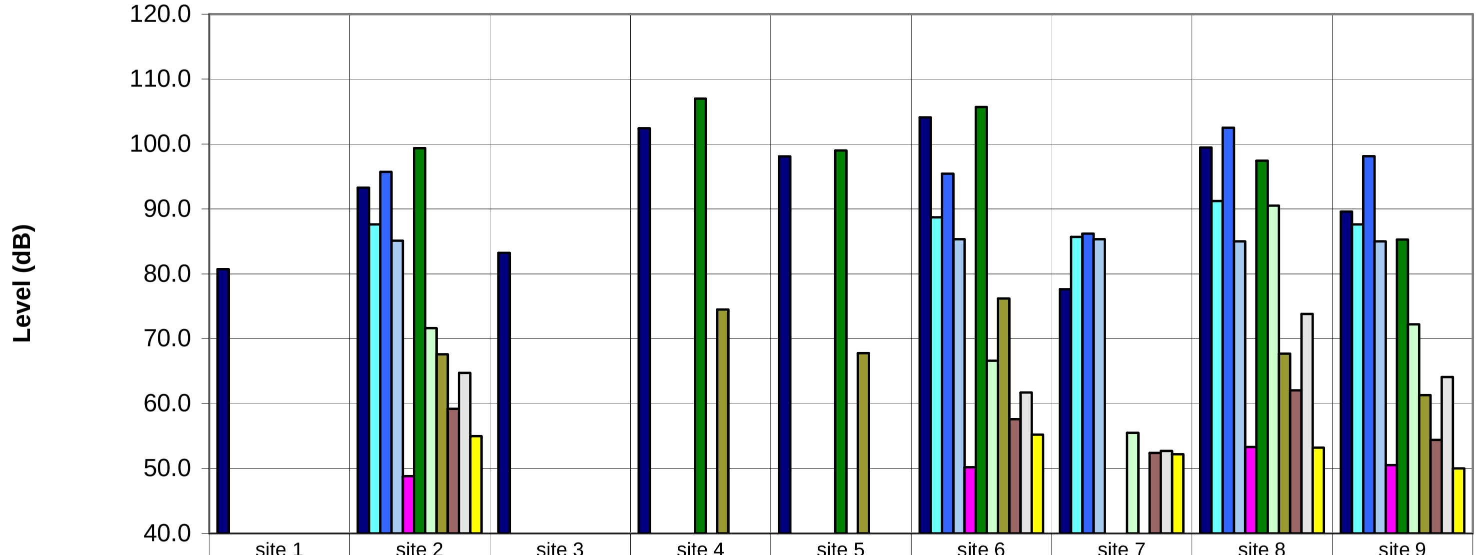
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	83.8	100.6	87.3	105.3	95.3	98.3	79.8	93.1	85.2
Monitoring Event Mean APeak				87.5				85.8	
Monitoring Event Max APeak				94.2				86.4	
Monitoring Event Min APeak				85.0				85.1	
LEQ (Monitoring Event & Amb.)									
SARNAM ASEL Total	-100.0	102.4	90.5	108.3	96.6	102.0	-100.0	96.5	-100.0
Monitoring ASEL Total				71.3				55.9	
SARNAM Event ASEL	-100.0	75.0	63.1	80.7	68.0	71.7	-100.0	67.9	-100.0
Monitoring Event Mean ASEL				54.8				52.8	
Monitoring Event Max ASEL				65.6				53.5	
Monitoring Event Min ASEL				50.0				52.1	

NOISE MONITORING DATA
Range A (9mm), Range C (5.56)
22 July 2001
1100 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	Unit Down	Unit Down	No Files	32	<TL	<TL	<TL	2	Unit Down
Monitoring Event Mean APeak				87.5				85.8	
Standard Deviation Event APeak				2				0.9	
85-95				32				2	
95-105				0				0	
105-115				0				0	
115-125				0				0	
≥125				0				0	
Monitoring ASEL Total				71.3				55.9	
Monitoring Event Mean ASEL				54.8				52.8	
Standard Deviation Event ASEL				2.9				1	
40-50				0				0	
50-60				31				2	
60-70				1				0	
70-80				0				0	
80-90				0				0	
90-100				0				0	
>100				0				0	

TL=Trigger Level

Range A (12 gauge/9mm), Range C (9mm)
27 July 2001



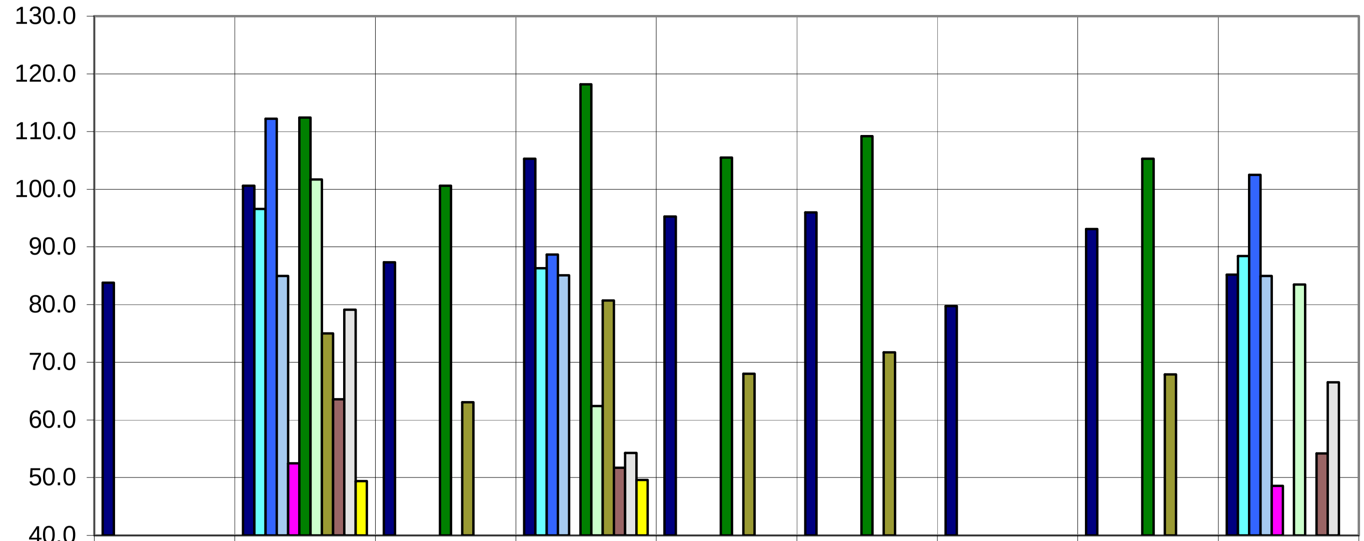
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	80.7	93.3	83.2	102.4	98.1	104.1	77.6	99.4	89.6
Monitoring Event Mean APeak		87.6				88.7	85.7	91.2	87.6
Monitoring Event Max APeak		95.7				95.4	86.2	102.5	98.1
Monitoring Event Min APeak		85.1				85.3	85.3	85.0	85.0
LEQ (Monitoring Event & Amb.)		48.8				50.2		53.3	50.5
SARNAM ASEL Total	-100.0	99.3	-100.0	107.0	99.0	105.7	-100.0	97.4	85.3
Monitoring ASEL Total		71.6				66.6	55.5	90.5	72.2
SARNAM Event ASEL	-100.0	67.6	-100.0	74.5	67.8	76.2	-100.0	67.7	61.3
Monitoring Event Mean ASEL		59.2				57.6	52.4	62.0	54.4
Monitoring Event Max ASEL		64.7				61.7	52.7	73.8	64.1
Monitoring Event Min ASEL		55.0				55.2	52.2	53.2	50.0

NOISE MONITORING DATA
Range A (12 gauge/9mm), Range C (9mm)
27 July 2001
3250 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	Unit Down	15	<TL	<TL	<TL	7	2	478	43
Monitoring Event Mean APeak		87.6				88.7	85.7	91.2	87.6
Standard Deviation Event APeak		3				3.7	0.6	4.1	2.9
85-95		14				6	2	382	41
95-105		1				1	0	96	2
105-115		0				0	0	0	0
115-125		0				0	0	0	0
≥125		0				0	0	0	0
Monitoring ASEL Total		71.6				66.6	55.5	90.5	72.2
Monitoring Event Mean ASEL		59.2				57.6	52.4	62	54.4
Standard Deviation Event ASEL		2.3				2.2	0.3	3.7	3.1
40-50		0				0	0	0	1
50-60		10				6	2	145	39
60-70		5				1	0	323	3
70-80		0				0	0	10	0
80-90		0				0	0	0	0
90-100		0				0	0	0	0
>100		0				0	0	0	0

TL=Trigger Level

Range C (5.56)
28 July 2001



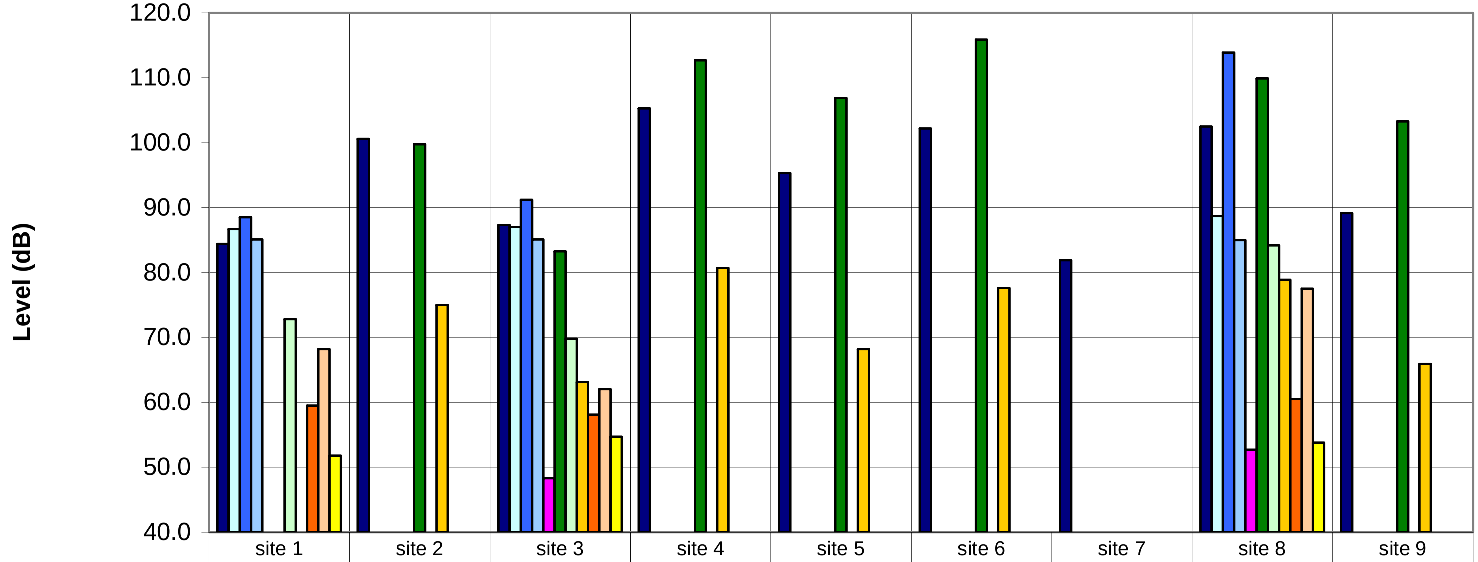
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	83.8	100.6	87.3	105.3	95.3	96.0	79.7	93.1	85.2
Monitoring Event Mean APeak		96.6		86.3					88.4
Monitoring Event Max APeak		112.2		88.7					102.5
Monitoring Event Min APeak		85.0		85.1					85.0
LEQ (Monitoring Event & Amb.)		52.5							48.6
SARNAM ASEL Total	-100.0	112.4	100.6	118.2	105.5	109.2	-100.0	105.3	-100.0
Monitoring ASEL Total		101.7		62.4					83.5
SARNAM Event ASEL	-100.0	75.0	63.1	80.7	68.0	71.7	-100.0	67.9	-100.0
Monitoring Event Mean ASEL		63.6		51.7					54.2
Monitoring Event Max ASEL		79.1		54.3					66.5
Monitoring Event Min ASEL		49.4		49.6					38.2

NOISE MONITORING DATA
Range C (5.56)
28 July 2001
5600 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	Unit Down	3029	<TL	11	<TL	<TL	<TL	No Files	621
Monitoring Event Mean APeak		96.6		86.3					88.4
Standard Deviation Event APeak		6.4		1					3
85-95		1191		11					597
95-105		1557		0					24
105-115		281		0					0
115-125		0		0					0
≥125		0		0					0
Monitoring ASEL Total		101.7		62.4					83.5
Monitoring Event Mean ASEL		63.6		51.7					54.2
Standard Deviation Event ASEL		5.5		1.8					3.2
40-50		3		4					40
50-60		870		7					552
60-70		1728		0					28
70-80		428		0					0
80-90		0		0					0
90-100		0		0					0
>100		0		0					0
<40		0		0					1

TL=Trigger Level

Range A (5.56), Range B (5.56), Range C (5.56/9mm)
23 August 2001



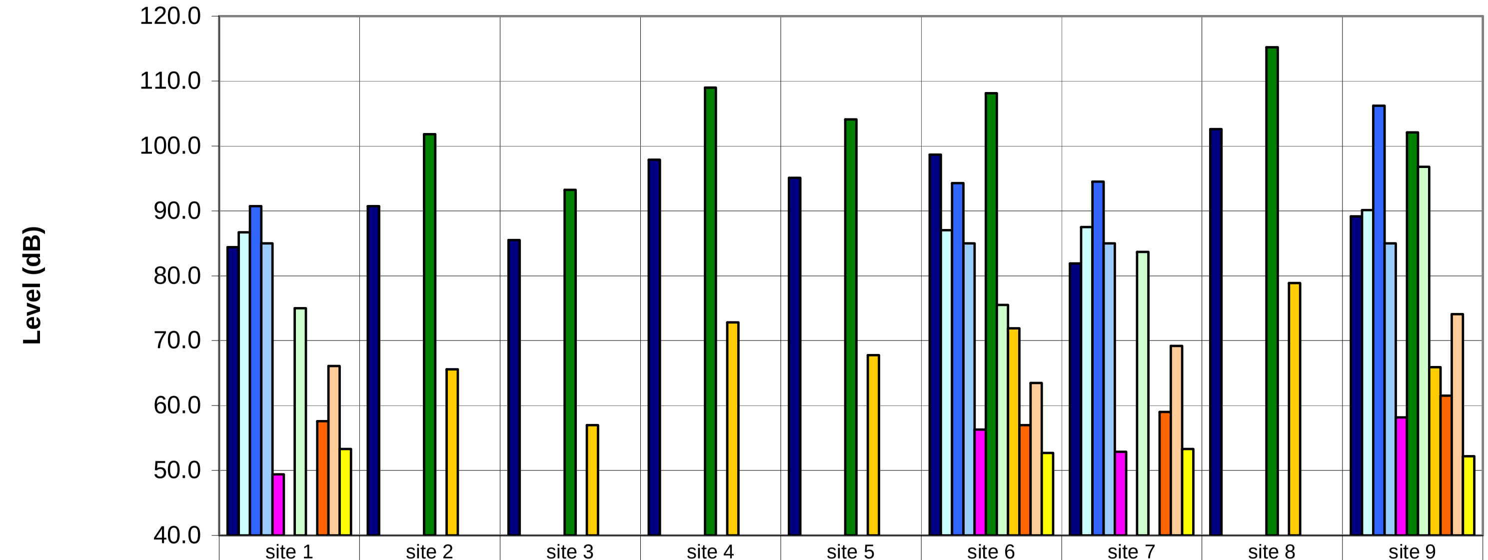
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	84.4	100.6	87.3	105.3	95.3	102.2	81.9	102.5	89.2
Monitoring Event Mean APeak	86.7		87.0					88.7	
Monitoring Event Max APeak	88.5		91.2					113.9	
Monitoring Event Min APeak	85.1		85.1					85.0	
LEQ (Monitoring Event & Amb.)			48.3					52.7	
SARNAM ASEL Total	-100.0	99.8	83.3	112.7	106.9	115.9	-100.0	109.9	103.3
Monitoring ASEL Total	72.8		69.8					84.2	
SARNAM Event ASEL	-100.0	75.0	63.1	80.7	68.2	77.6	-100.0	78.9	65.9
Monitoring Event Mean ASEL	59.5		58.1					60.5	
Monitoring Event Max ASEL	68.2		62.0					77.5	
Monitoring Event Min ASEL	51.8		54.7					53.8	

NOISE MONITORING DATA
Range A (5.56), Range B (5.56), Range C (5.56/9mm)
23 August 2001
8100 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	15	<TL	12	Unit Down	<TL	<TL	<TL	157	<TL
Monitoring Event Mean APeak	86.7		87					88.7	
Standard Deviation Event APeak	1.1		1.9					3.4	
85-95	15		12					153	
95-105	0		0					3	
105-115	0		0					1	
115-125	0		0					0	
≥125	0		0					0	
Monitoring ASEL Total	72.8		69.8					84.2	
Monitoring Event Mean ASEL	59.5		58.1					60.5	
Standard Deviation Event ASEL	3.5		3					2.9	
40-50	0		0					0	
50-60	9		8					68	
60-70	6		4					88	
70-80	0		0					1	
80-90	0		0					0	
90-100	0		0					0	
>100	0		0					0	

TL=Trigger Level

Range B (5.56)
24 August 2001



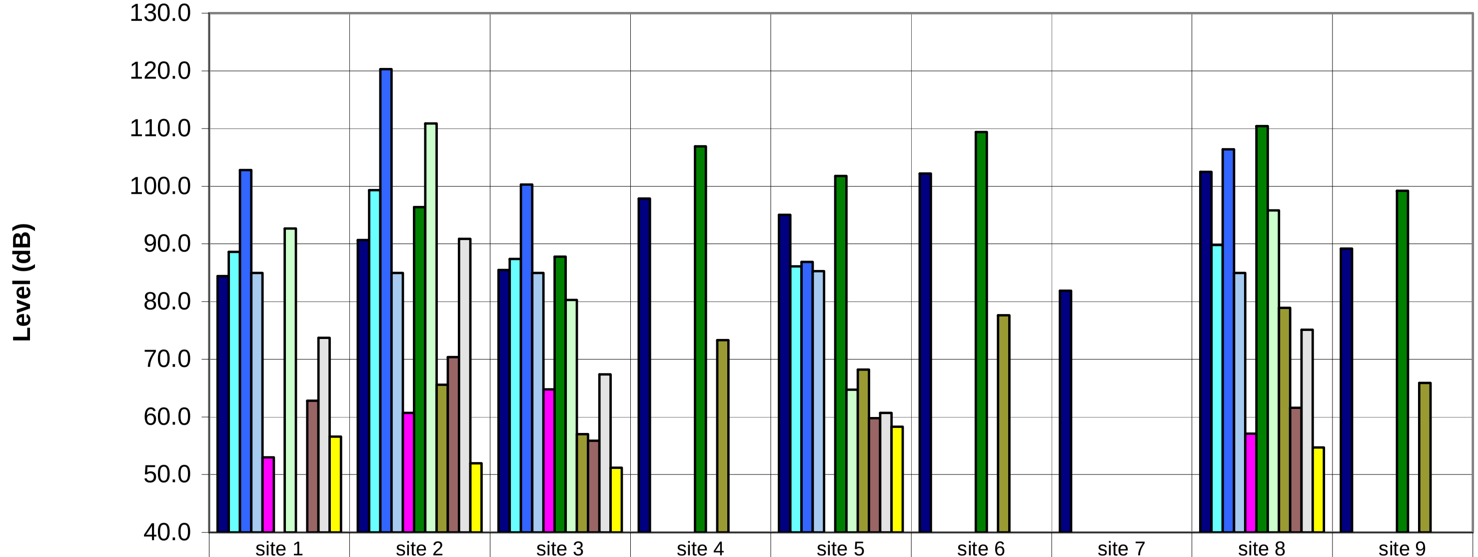
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	84.4	90.7	85.5	97.9	95.1	98.7	81.9	102.6	89.2
Monitoring Event Mean APeak	86.7					87.0	87.5		90.1
Monitoring Event Max APeak	90.7					94.3	94.5		106.2
Monitoring Event Min APeak	85.0					85.0	85.0		85.0
LEQ (Monitoring Event & Amb.)	49.4					56.3	52.9		58.2
SARNAM ASEL Total	-100.0	101.8	93.2	109.0	104.1	108.1	-100.0	115.2	102.1
Monitoring ASEL Total	75.0					75.5	83.7		96.8
SARNAM Event ASEL	-100.0	65.6	57.0	72.8	67.8	71.9	-100.0	78.9	65.9
Monitoring Event Mean ASEL	57.6					57.0	59.0		61.5
Monitoring Event Max ASEL	66.1					63.5	69.2		74.1
Monitoring Event Min ASEL	53.3					52.7	53.3		52.2

NOISE MONITORING DATA
Range B (5.56)
24 August 2001
4200 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	47	<TL	<TL	<TL	<TL	63	236	Unit Down	2369
Monitoring Event Mean APeak	86.7					87	87.5		90.1
Standard Deviation Event APeak	1.4					1.9	2.2		3.7
85-95	47					63	236		2098
95-105	0					0	0		269
105-115	0					0	0		2
115-125	0					0	0		0
≥125	0					0	0		0
Monitoring ASEL Total	75					75.5	83.7		96.8
Monitoring Event Mean ASEL	57.6					57	59		61.5
Standard Deviation Event ASEL	2.3					2	2.6		3.5
40-50	0					0	0		0
50-60	42					58	161		860
60-70	5					5	75		1479
70-80	0					0	0		30
80-90	0					0	0		0
90-100	0					0	0		0
>100	0					0	0		0

TL=Trigger Level

Range A (5.56), Range B (5.56)
07 September 2001



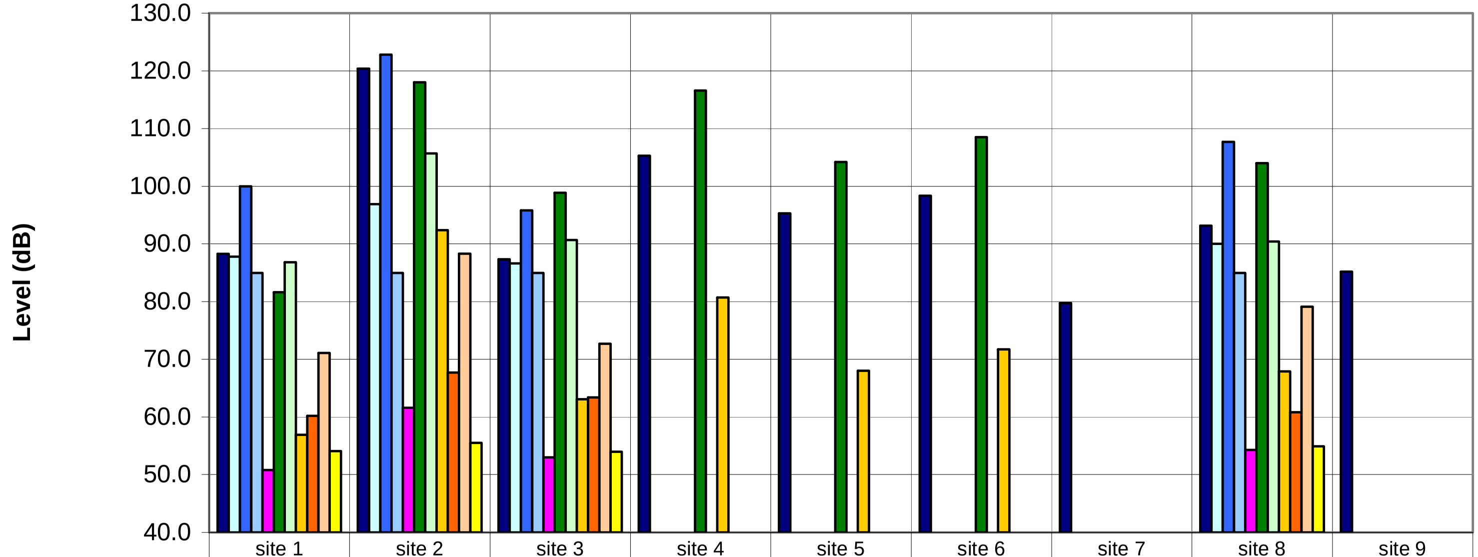
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	84.4	90.7	85.5	97.9	95.1	102.2	81.9	102.5	89.2
Monitoring Event Mean APeak	88.6	99.3	87.4		86.1			89.8	
Monitoring Event Max APeak	102.8	120.3	100.3		86.9			106.4	
Monitoring Event Min APeak	85.0	85.0	85.0		85.3			85.0	
LEQ (Monitoring Event & Amb.)	53.0	60.7	64.8					57.1	
SARNAM ASEL Total	-100.0	96.4	87.8	106.9	101.8	109.4	-100.0	110.4	99.2
Monitoring ASEL Total	92.7	110.9	80.3		64.7			95.8	
SARNAM Event ASEL	-100.0	65.6	57.0	73.3	68.2	77.6	-100.0	78.9	65.9
Monitoring Event Mean ASEL	62.8	70.4	55.9		59.8			61.6	
Monitoring Event Max ASEL	73.7	90.9	67.4		60.7			75.1	
Monitoring Event Min ASEL	56.6	52.0	51.2		58.3			54.7	

NOISE MONITORING DATA
Range A (5.56), Range B (5.56)
07 September 2001
2400 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	717	4965	228	Unit Down	3	<TL	<TL	1926	No Files
Monitoring Event Mean APeak	88.6	99.3	87.4		86.1			89.8	
Standard Deviation Event APeak	3.1	6.1	2.4		0.8			3.8	
85-95	681	1181	225		3			1718	
95-105	36	2855	3		0			204	
105-115	0	914	0		0			4	
115-125	0	15	0		0			0	
≥125	0	0	0		0			0	
Monitoring ASEL Total	92.7	110.9	80.3		64.7			95.8	
Monitoring Event Mean ASEL	62.8	70.4	55.9		59.8			61.6	
Standard Deviation Event ASEL	3.2	5.6	2.3		1.3			3.1	
40-50	0	0	0		0			0	
50-60	142	127	215		1			636	
60-70	551	2260	13		2			1275	
70-80	24	2368	0		0			15	
80-90	0	209	0		0			0	
90-100	0	1	0		0			0	
>100	0	0	0		0			0	

TL=Trigger Level

Range A (9mm), Range C (5.56), Range D (9mm)
08 September 2001



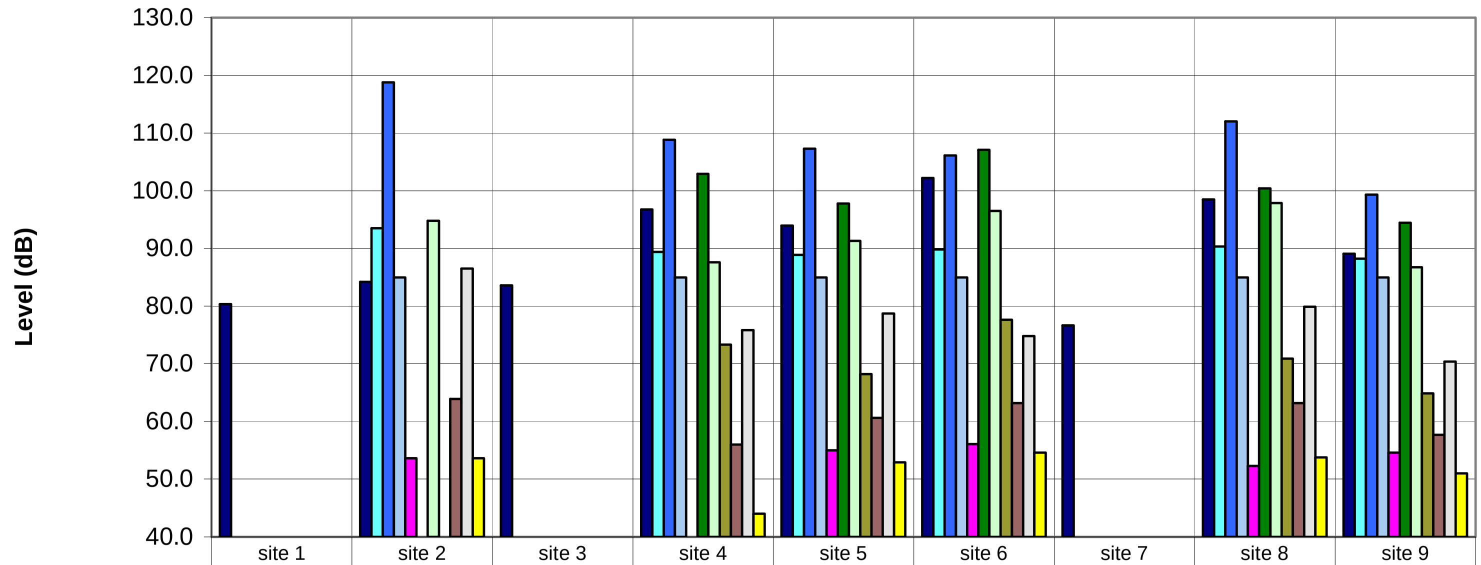
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	88.3	120.4	87.3	105.3	95.3	98.3	79.8	93.1	85.2
Monitoring Event Mean APeak	87.8	96.9	86.6					90.0	
Monitoring Event Max APeak	100.0	122.8	95.8					107.7	
Monitoring Event Min APeak	85.0	85.0	85.0					85.0	
LEQ (Monitoring Event & Amb.)	50.8	61.6	53.0					54.3	
SARNAM ASEL Total	81.6	118.0	98.9	116.6	104.2	108.5	-100.0	104.0	-100.0
Monitoring ASEL Total	86.8	105.7	90.7					90.4	
SARNAM Event ASEL	56.9	92.4	63.1	80.7	68.0	71.7	-100.0	67.9	-100.0
Monitoring Event Mean ASEL	60.2	67.7	63.4					60.8	
Monitoring Event Max ASEL	71.1	88.3	72.7					79.1	
Monitoring Event Min ASEL	54.1	55.5	54.0					54.9	

NOISE MONITORING DATA
Range A (9mm), Range C (5.56), Range D (9mm)
08 September 2001
5055 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	377	2133	222	Unit Down	No Files	<TL	<TL	586	No Files
Monitoring Event Mean APeak	87.8	96.9	86.6					90	
Standard Deviation Event APeak	2.5	7.7	2					4.1	
85-95	372	993	220					503	
95-105	5	771	2					82	
105-115	0	359	0					1	
115-125	0	10	0					0	
≥125	0	0	0					0	
Monitoring ASEL Total	86.8	105.7	90.7					90.4	
Monitoring Event Mean ASEL	60.2	67.7	63.4					60.8	
Standard Deviation Event ASEL	2.6	5.9	6					3.3	
40-50	0	0	0					0	
50-60	193	120	94					268	
60-70	183	1389	65					307	
70-80	1	556	63					11	
80-90	0	68	0					0	
90-100	0	0	0					0	
>100	0	0	0					0	

TL=Trigger Level

Range A (5.56)
13 September 2001



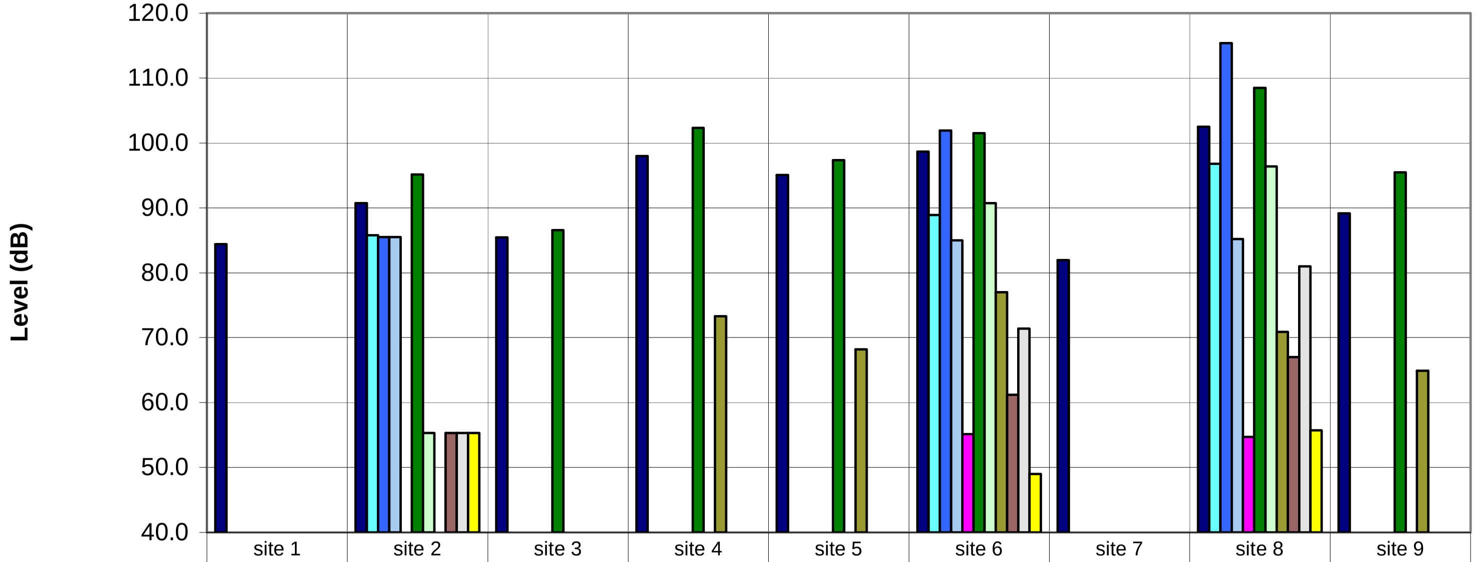
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	80.3	84.2	83.6	96.7	94.0	102.2	76.7	98.5	89.1
Monitoring Event Mean APeak		93.5		89.4	88.9	89.8		90.3	88.2
Monitoring Event Max APeak		118.8		108.8	107.3	106.1		112.0	99.3
Monitoring Event Min APeak		85.0		85.0	85.0	85.0		85.0	85.0
LEQ (Monitoring Event & Amb.)		53.6			55.0	56.1		52.3	54.6
SARNAM ASEL Total	-100.0	-100.0	-100.0	102.9	97.8	107.1	-100.0	100.4	94.4
Monitoring ASEL Total		94.8		87.6	91.3	96.5		97.9	86.7
SARNAM Event ASEL	-100.0	-100.0	-100.0	73.3	68.2	77.6	-100.0	70.9	64.9
Monitoring Event Mean ASEL		63.9		56.0	60.6	63.2		63.2	57.7
Monitoring Event Max ASEL		86.5		75.8	78.7	74.8		79.9	70.4
Monitoring Event Min ASEL		53.6		44.0	52.9	54.6		53.8	51.0

NOISE MONITORING DATA
Range A (5.56)
13 September 2001
900 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	<TL	483	<TL	866	883	1490	Site Dropped	1808	434
Monitoring Event Mean APeak		93.5		89.4	88.9	89.9		90.3	88.2
Standard Deviation Event APeak		6.2		4.1	3.3	3.7		4.1	2.6
85-95		286		770	831	1329		1556	424
95-105		175		96	51	1600		241	10
105-115		21		3	1	1		11	0
115-125		1		0	0	0		0	0
≥125		0		0	0	0		0	0
Monitoring ASEL Total		94.8		87.6	91.3	96.5		97.9	86.7
Monitoring Event Mean ASEL		63.9		56	60.6	63.2		63.2	57.7
Standard Deviation Event ASEL		5.6		3.6	2.7	3.6		4.1	4.1
40-50		0		8	0	0		0	0
50-60		144		754	398	316		446	347
60-70		263		101	480	1123		1261	85
70-80		75		3	5	51		101	2
80-90		1		0	0	0		0	0
90-100		0		0	0	0		0	0
>100		0		0	0	0		0	0

TL=Trigger Level

Range A (5.56)
14 September 2001



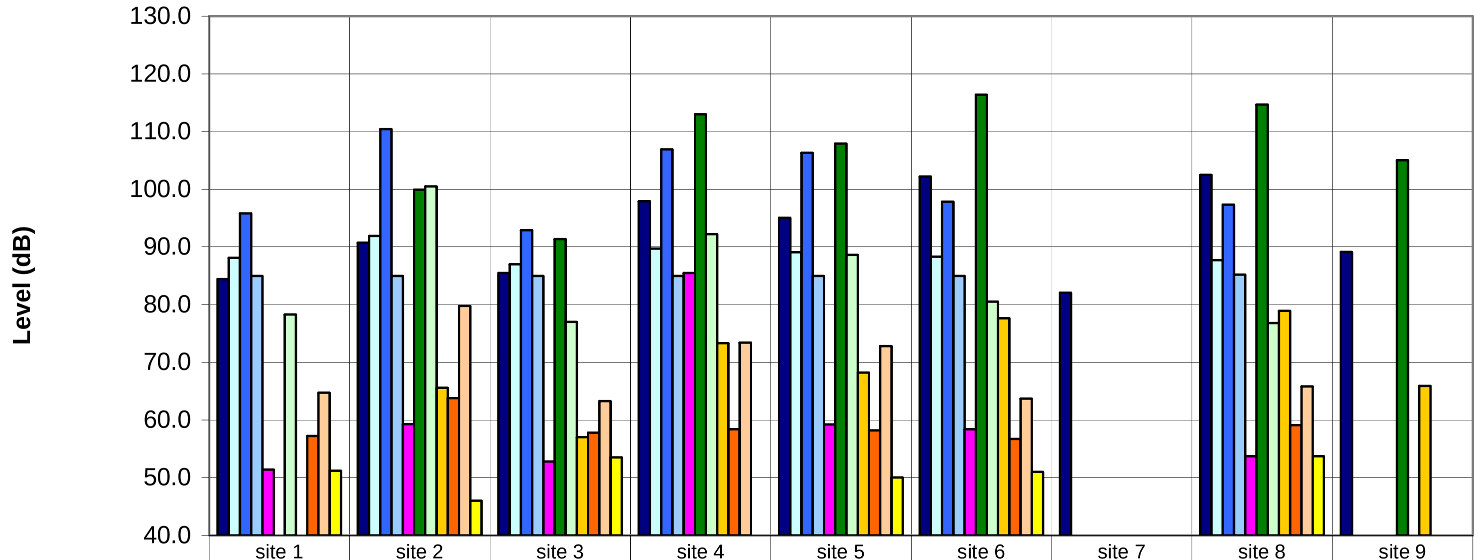
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	84.4	90.7	85.5	98.0	95.0	98.7	81.9	102.5	89.2
Monitoring Event Mean APeak		85.8				88.9		96.8	
Monitoring Event Max APeak		85.5				101.9		115.4	
Monitoring Event Min APeak		85.5				85.0		85.2	
LEQ (Monitoring Event & Amb.)						55.1		54.7	
SARNAM ASEL Total	-100.0	95.2	86.6	102.3	97.4	101.5	-100.0	108.5	95.5
Monitoring ASEL Total		55.3				90.7		96.4	
SARNAM Event ASEL	-100.0	-100.0	-100.0	73.3	68.2	77.0	-100.0	70.9	64.9
Monitoring Event Mean ASEL		55.3				61.2		67.0	
Monitoring Event Max ASEL		55.3				71.4		81.0	
Monitoring Event Min ASEL		55.3				49.0		55.7	

NOISE MONITORING DATA
Range B (5.56)
14 September 2001
900 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	<TL	1	Unit Down	<TL	<TL	671	Site Dropped	449	Unit Down
Monitoring Event Mean APeak		85.5				88.9		96.8	
Standard Deviation Event APeak		0				3.3		7	
85-95		1				630		185	
95-105		0				41		200	
105-115		0				0		63	
115-125		0				0		1	
≥125		0				0		0	
Monitoring ASEL Total		55.3				90.7		96.4	
Monitoring Event Mean ASEL		55.3				61.2		67	
Standard Deviation Event ASEL		0				3.2		5.1	
40-50		0				1		0	
50-60		1				227		41	
60-70		0				438		270	
70-80		0				5		137	
80-90		0				0		1	
90-100		0				0		0	
>100		0				0		0	

TL=Trigger Level

Range A (5.56), Range B (5.56)
19 September 2001



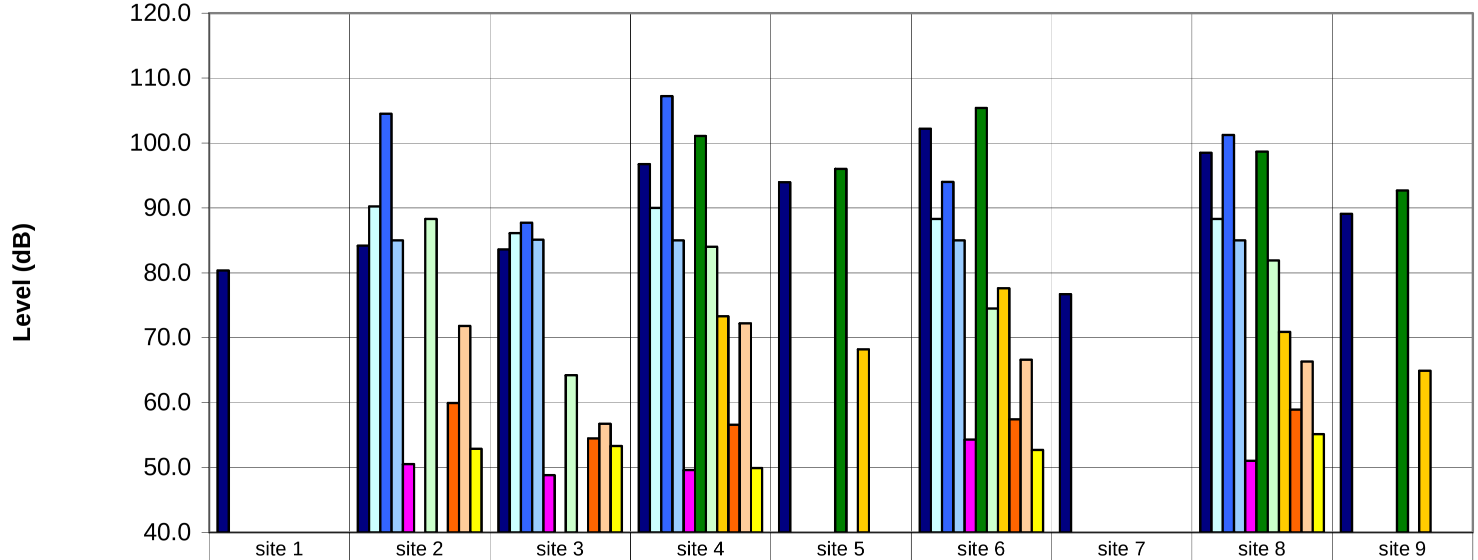
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	84.4	90.7	85.5	97.9	95.1	102.2	82.0	102.5	89.2
Monitoring Event Mean APeak	88.1	91.9	87.0	89.7	89.1	88.3		87.7	
Monitoring Event Max APeak	95.8	110.4	92.9	106.9	106.3	97.8		97.3	
Monitoring Event Min APeak	85.0	85.0	85.0	85.0	85.0	85.0		85.2	
LEQ (Monitoring Event & Amb.)	51.4	59.3	52.8	85.5	59.2	58.4		53.7	
SARNAM ASEL Total	-100.0	100.0	91.4	113.0	107.9	116.4	-100.0	114.7	105.0
Monitoring ASEL Total	78.3	100.5	77.0	92.2	88.6	80.5		76.8	
SARNAM Event ASEL	-100.0	65.6	57.0	73.3	68.2	77.6	-100.0	78.9	65.9
Monitoring Event Mean ASEL	57.2	63.8	57.8	58.4	58.2	56.7		59.1	
Monitoring Event Max ASEL	64.7	79.8	63.3	73.4	72.8	63.7		65.8	
Monitoring Event Min ASEL	51.2	46.0	53.5	39.6	50.0	51.0		53.7	

NOISE MONITORING DATA
Range A (5.56), Range B (5.56)
19 September 2001
9520 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	108	2705	76	1650	837	209	Site Dropped	49	No Files
Monitoring Event Mean APeak	88.1	91.9	87	89.7	89.1	88.3		87.7	
Standard Deviation Event APeak	2.5	4.7	1.7	3.7	3.6	2.8		3	
85-95	107	2001	76	1492	770	200		48	
95-105	1	691	0	156	65	9		1	
105-115	0	13	0	2	2	0		0	
115-125	0	0	0	0	0	0		0	
≥125	0	0	0	0	0	0		0	
Monitoring ASEL Total	78.3	100.5	77	92.2	88.6	80.5		76.8	
Monitoring Event Mean ASEL	57.2	63.8	57.8	58.4	58.2	56.7		59.1	
Standard Deviation Event ASEL	2.5	4.4	1.9	3.4	2.9	2.2		2.5	
40-50	0	1	0	2	1	0		0	
50-60	92	564	66	1162	639	193		33	
60-70	16	1902	10	477	195	16		16	
70-80	0	238	0	8	2	0		0	
80-90	0	0	0	0	0	0		0	
90-100	0	0	0	0	0	0		0	
>100	0	0	0	0	0	0		0	

TL=Trigger Level

Range A (5.56)
21 September 2001



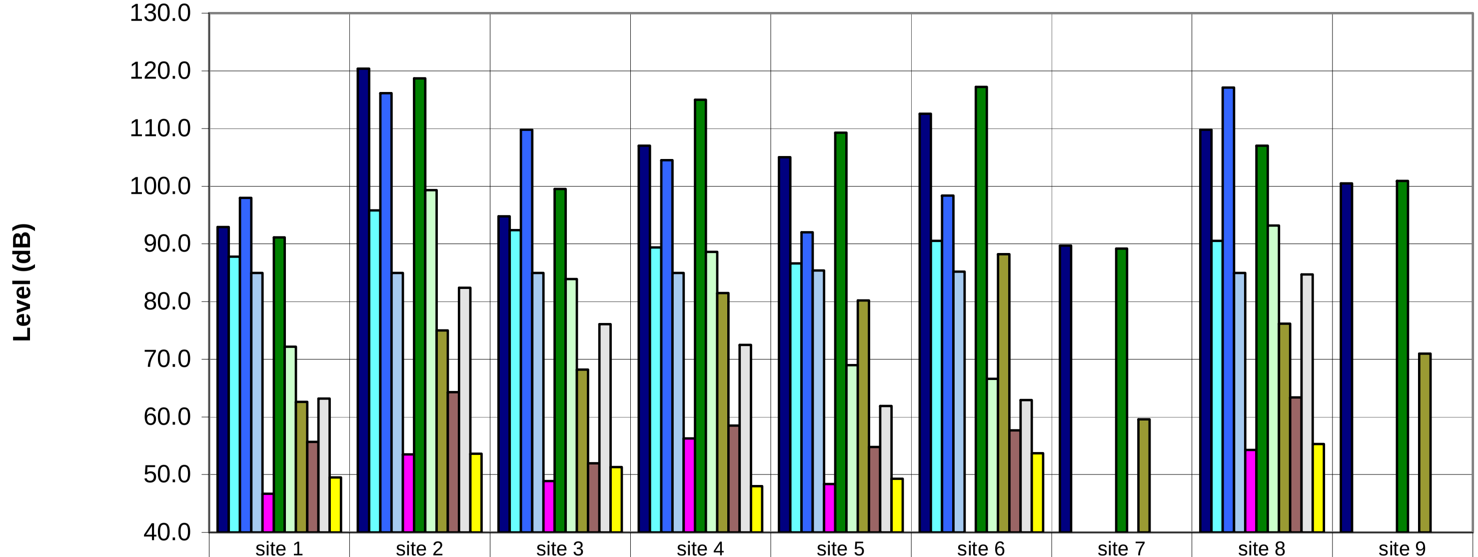
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	80.3	84.2	83.6	96.7	94.0	102.2	76.7	98.5	89.1
Monitoring Event Mean APeak		90.2	86.1	90.0		88.3		88.3	
Monitoring Event Max APeak		104.5	87.7	107.2		94.0		101.2	
Monitoring Event Min APeak		85.0	85.1	85.0		85.0		85.0	
LEQ (Monitoring Event & Amb.)		50.5	48.8	49.6		54.3		51.0	
SARNAM ASEL Total	-100.0	-100.0	-100.0	101.1	96.0	105.4	-100.0	98.7	92.7
Monitoring ASEL Total		88.3	64.2	84.0		74.5		81.9	
SARNAM Event ASEL	-100.0	-100.0	-100.0	73.3	68.2	77.6	-100.0	70.9	64.9
Monitoring Event Mean ASEL		59.9	54.5	56.6		57.4		58.9	
Monitoring Event Max ASEL		71.8	56.7	72.2		66.6		66.3	
Monitoring Event Min ASEL		52.9	53.3	49.9		52.7		55.1	

NOISE MONITORING DATA
Range A (5.56)
21 September 2001
600 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	<TL	518	9	348	Unit Down	38	Site Dropped	182	No Files
Monitoring Event Mean APeak		90.2	86.1	90		88.3		88.3	
Standard Deviation Event APeak		4	0.9	4.1		2.6		2.7	
85-95		443	9	301		38		180	
95-105		75	0	44		0		2	
105-115		0	0	3		0		0	
115-125		0	0	0		0		0	
≥125		0	0	0		0		0	
Monitoring ASEL Total		88.3	64.2	84		74.5		81.9	
Monitoring Event Mean ASEL		59.9	54.5	56.6		57.4		58.9	
Standard Deviation Event ASEL		3.1	1.1	3.5		3		1.8	
40-50		0	0	1		0		0	
50-60		302	9	292		32		135	
60-70		214	0	54		6		47	
70-80		2	0	1		0		0	
80-90		0	0	0		0		0	
90-100		0	0	0		0		0	
>100		0	0	0		0		0	

TL=Trigger Level

Range A (50 cal/7.62), Range C (5.56), Range D (9mm)
22 September 2001



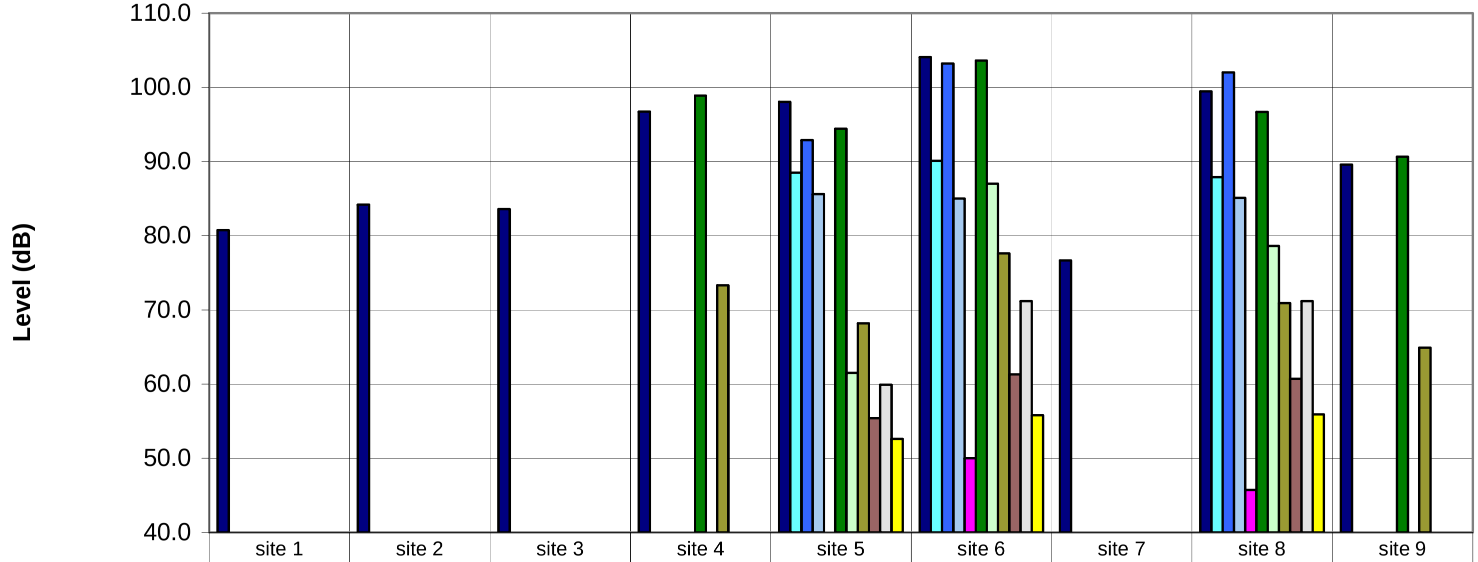
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	92.9	120.4	94.8	107.0	105.0	112.6	89.7	109.8	100.5
Monitoring Event Mean APeak	87.8	95.8	92.4	89.4	86.6	90.5		90.5	
Monitoring Event Max APeak	98.0	116.1	109.8	104.5	92.0	98.4		117.1	
Monitoring Event Min APeak	85.0	85.0	85.0	85.0	85.4	85.2		85.0	
LEQ (Monitoring Event & Amb.)	46.7	53.5	48.9	56.3	48.4			54.3	
SARNAM ASEL Total	91.2	118.7	99.5	115.0	109.3	117.2	89.2	107.0	100.9
Monitoring ASEL Total	72.2	99.3	83.9	88.6	69.0	66.6		93.2	
SARNAM Event ASEL	62.6	75.0	68.2	81.5	80.2	88.2	59.6	76.2	71.0
Monitoring Event Mean ASEL	55.7	64.3	52.0	58.5	54.8	57.7		63.4	
Monitoring Event Max ASEL	63.2	82.4	76.1	72.5	61.9	62.9		84.7	
Monitoring Event Min ASEL	49.5	53.6	51.3	48.0	49.3	53.7		55.3	

NOISE MONITORING DATA
Range A (50 cal/7.62), Range C (5.56), Range D (9mm)
22 September 2001
4586 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	35	1469	68	489	20	6	Site Dropped	308	No Files
Monitoring Event Mean APeak	87.8	95.8	92.4	89.4	86.6	90.5		90.5	
Standard Deviation Event APeak	3.1	6.9	5.2	3.9	1.5	5.1		6.3	
85-95	34	700	51	436	20	5		253	
95-105	1	599	15	53	0	1		43	
105-115	0	168	2	0	0	0		10	
115-125	0	2	0	0	0	0		2	
≥125	0	0	0	0	0	0		0	
Monitoring ASEL Total	72.2	99.3	83.9	88.6	69	66.6		93.2	
Monitoring Event Mean ASEL	55.7	64.3	62	58.5	54.8	57.7		63.4	
Standard Deviation Event ASEL	3	5.2	5.9	5	3	3.4		4.9	
40-50	1	0	0	2	1	0		0	
50-60	60	341	24	335	17	5		67	
60-70	4	893	41	144	2	1		208	
70-80	0	232	3	8	0	0		28	
80-90	0	3	0	0	0	0		5	
90-100	0	0	0	0	0	0		0	
>100	0	0	0	0	0	0		0	

TL=Trigger Level

Range A (5.56, 12 gauge, 22 L/R)
28 September 2001



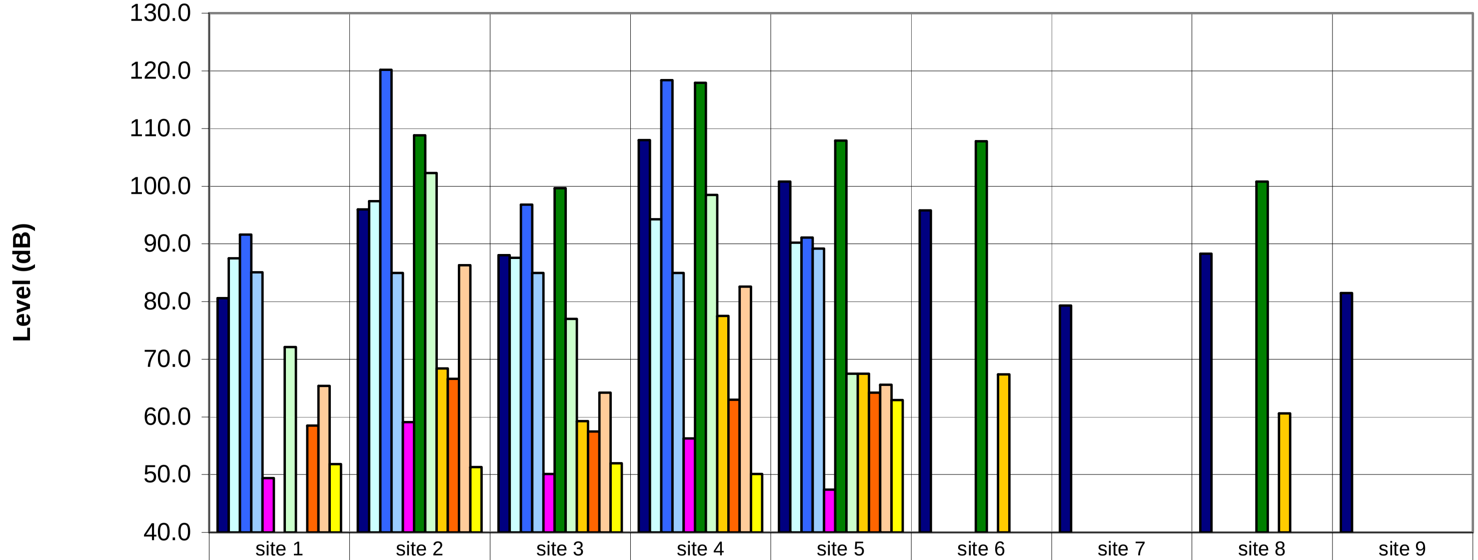
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	80.7	84.2	83.6	96.7	98.0	104.1	76.7	99.4	89.6
Monitoring Event Mean APeak					88.5	90.1		87.9	
Monitoring Event Max APeak					92.9	103.2		102.0	
Monitoring Event Min APeak					85.6	85.0		85.1	
LEQ (Monitoring Event & Amb.)						50.0		45.7	
SARNAM ASEL Total	-100.0	-100.0	-100.0	98.9	94.4	103.6	-100.0	96.7	90.7
Monitoring ASEL Total					61.5	87.0		78.6	
SARNAM Event ASEL	-100.0	-100.0	-100.0	73.3	68.2	77.6	-100.0	70.9	64.9
Monitoring Event Mean ASEL					55.4	61.3		60.7	
Monitoring Event Max ASEL					59.9	71.2		71.2	
Monitoring Event Min ASEL					52.6	55.8		55.9	

NOISE MONITORING DATA
Range A (5.56/12 guage/22 LR)
28 September 2001
595 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	<TL	<TL	<TL	<TL	3	307	Site Dropped	52	Unit Down
Monitoring Event Mean APeak					88.5	90.1		87.9	
Standard Deviation Event APeak					3.9	3.6		3.7	
85-95					3	274		49	
95-105					0	33		3	
105-115					0	0		0	
115-125					0	0		0	
≥125					0	0		0	
Monitoring ASEL Total					61.5	87		78.6	
Monitoring Event Mean ASEL					55.4	61.3		60.7	
Standard Deviation Event ASEL					3.9	2.5		2.4	
40-50					0	0		0	
50-60					3	104		23	
60-70					0	202		29	
70-80					0	1		0	
80-90					0	0		0	
90-100					0	0		0	
>100					0	0		0	

TL=Trigger Level

Range C (45 cal)
02 October 2001

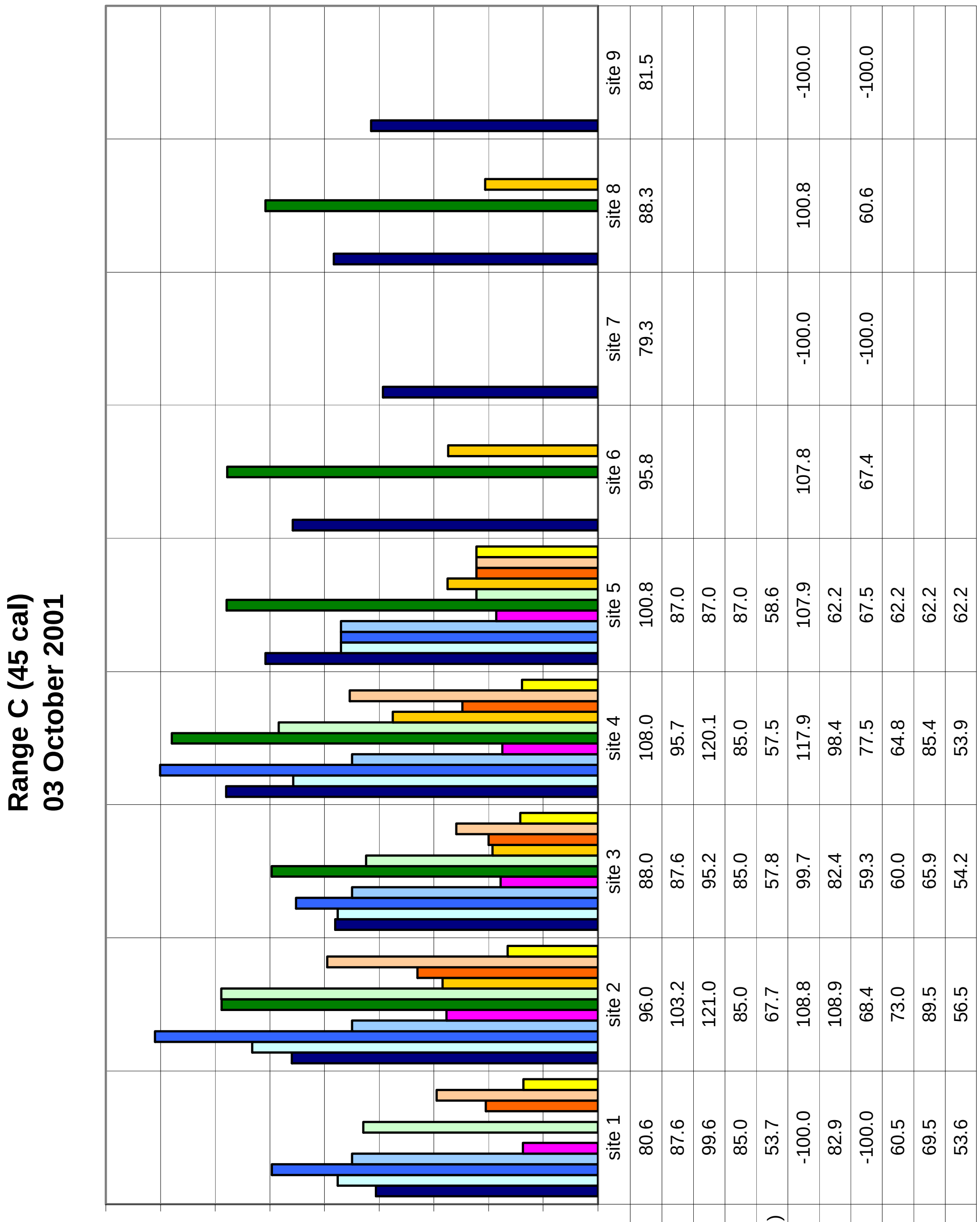


	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	80.6	96.0	88.0	108.0	100.8	95.8	79.3	88.3	81.5
Monitoring Event Mean APeak	87.5	97.4	87.6	94.3	90.2				
Monitoring Event Max APeak	91.6	120.2	96.8	118.4	91.1				
Monitoring Event Min APeak	85.1	85.0	85.0	85.0	89.2				
LEQ (Monitoring Event & Amb.)	49.4	59.1	50.1	56.3	47.4				
SARNAM ASEL Total	-100.0	108.8	99.7	117.9	107.9	107.8	-100.0	100.8	-100.0
Monitoring ASEL Total	72.1	102.3	77.0	98.5	67.5				
SARNAM Event ASEL	-100.0	68.4	59.3	77.5	67.5	67.4	-100.0	60.6	-100.0
Monitoring Event Mean ASEL	58.5	66.6	57.5	63.0	64.2				
Monitoring Event Max ASEL	65.4	86.3	64.2	82.6	65.6				
Monitoring Event Min ASEL	51.8	51.3	52.0	50.1	62.9				

NOISE MONITORING DATA
Range C (45 cal)
02 October 2001
11000 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	18	1435	69	1222	2	<TL	Site Dropped	<TL	Unit Down
Monitoring Event Mean APeak	87.5	97.4	87.6	94.3	90.2				
Standard Deviation Event APeak	2	6.1	2.7	6.1	1.4				
85-95	18	513	68	718	2				
95-105	0	752	1	430	0				
105-115	0	164	0	71	0				
115-125	0	6	0	3	0				
≥125	0	0	0	0	0				
Monitoring ASEL Total	72.1	102.3	77	98.5	67.5				
Monitoring Event Mean ASEL	58.5	66.6	57.5	63	64.2				
Standard Deviation Event ASEL	3.1	5.9	3.1	6	1.9				
40-50	0	0	0	0	0				
50-60	13	188	51	449	2				
60-70	5	845	18	606	0				
70-80	0	383	0	160	0				
80-90	0	19	0	7	0				
90-100	0	0	0	0	0				
>100	0	0	0	0	0				

TL=Trigger Level



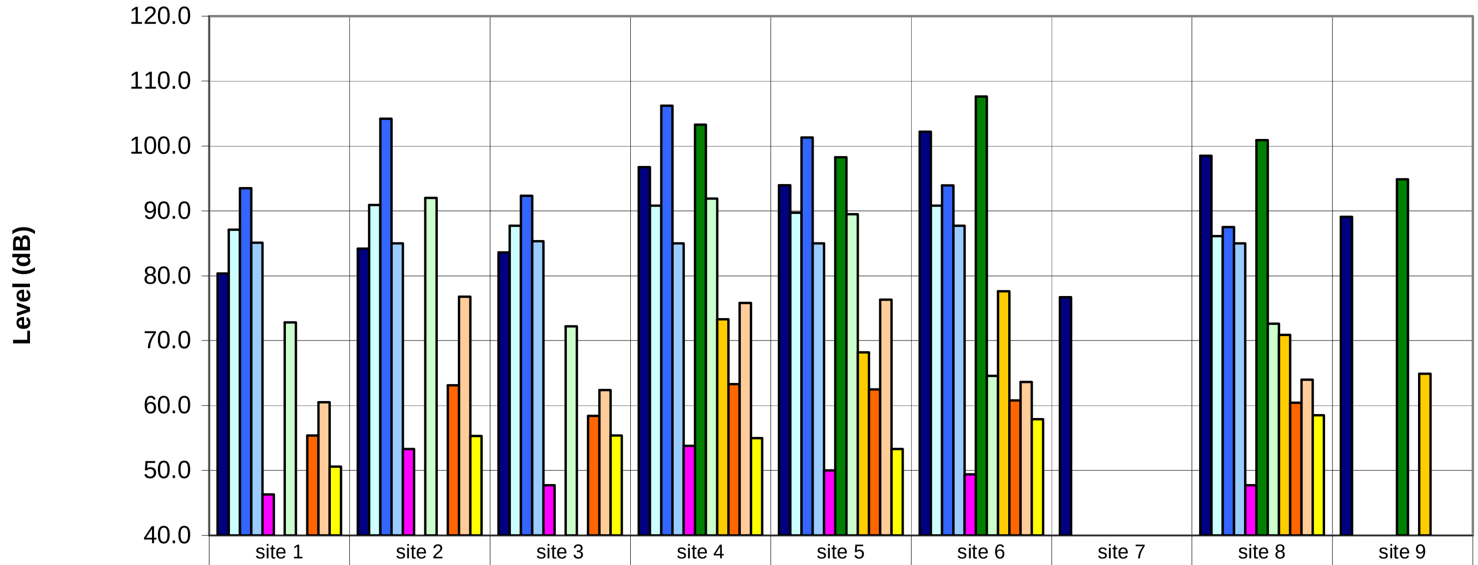
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	80.6	96.0	88.0	108.0	100.8	95.8	79.3	88.3	81.5
Monitoring Event Mean APeak	87.6	103.2	87.6	95.7	87.0				
Monitoring Event Max APeak	99.6	121.0	95.2	120.1	87.0				
Monitoring Event Min APeak	85.0	85.0	85.0	85.0	87.0				
LEQ (Monitoring Event & Amb.)	53.7	67.7	57.8	57.5	58.6				
SARNAM ASEL Total	-100.0	108.8	99.7	117.9	107.9	107.8	-100.0	100.8	-100.0
Monitoring ASEL Total	82.9	108.9	82.4	98.4	62.2				
SARNAM Event ASEL	-100.0	68.4	59.3	77.5	67.5	67.4	-100.0	60.6	-100.0
Monitoring Event Mean ASEL	60.5	73.0	60.0	64.8	62.2				
Monitoring Event Max ASEL	69.5	89.5	65.9	85.4	62.2				
Monitoring Event Min ASEL	53.6	56.5	54.2	53.9	62.2				

NOISE MONITORING DATA
Range C (45 cal)
03 October 2001
11000 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	145	1146	149	1080	1	<TL	Site Dropped	<TL	Unit Down
Monitoring Event Mean APeak	87.6	103.2	87.6	95.7	87				
Standard Deviation Event APeak	2.4	8.8	2.5	5.9	0				
85-95	144	250	145	518	1				
95-105	1	316	4	485	0				
105-115	0	498	0	73	0				
115-125	0	82	0	4	0				
≥125	0	0	0	0	0				
Monitoring ASEL Total	82.9	108.9	82.4	98.4	62.2				
Monitoring Event Mean ASEL	60.5	73	60	64.8	62.2				
Standard Deviation Event ASEL	2.6	7.5	2.4	4.7	0				
40-50	0	0	0	0	0				
50-60	66	32	72	156	1				
60-70	79	399	77	772	0				
70-80	0	475	0	150	0				
80-90	0	240	0	2	0				
90-100	0	0	0	0	0				
>100	0	0	0	0	0				

TL=Trigger Level

Range A (5.56)
15 October 2001



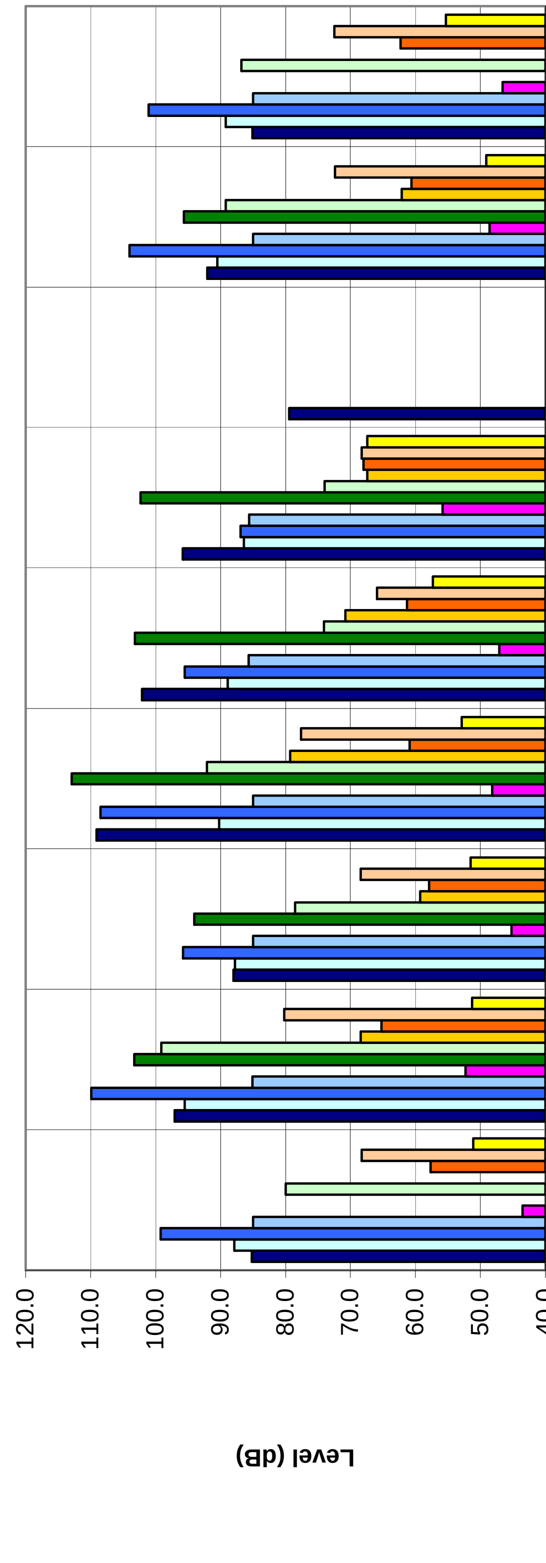
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	80.3	84.2	83.6	96.7	94.0	102.2	76.7	98.5	89.1
Monitoring Event Mean APeak	87.1	90.9	87.7	90.8	89.7	90.8		86.1	
Monitoring Event Max APeak	93.5	104.2	92.3	106.2	101.3	93.9		87.5	
Monitoring Event Min APeak	85.1	85.0	85.3	85.0	85.0	87.7		85.0	
LEQ (Monitoring Event & Amb.)	46.3	53.3	47.7	53.8	50.0	49.4		47.7	
SARNAM ASEL Total	-100.0	-100.0	-100.0	103.3	98.2	107.6	-100.0	100.9	94.9
Monitoring ASEL Total	72.8	92.0	72.2	91.9	89.5	64.6		72.6	
SARNAM Event ASEL	-100.0	-100.0	-100.0	73.3	68.2	77.6	-100.0	70.9	64.9
Monitoring Event Mean ASEL	55.4	63.1	58.4	63.3	62.5	60.8		60.4	
Monitoring Event Max ASEL	60.5	76.8	62.4	75.8	76.3	63.6		64.0	
Monitoring Event Min ASEL	50.6	55.3	55.4	55.0	53.3	57.9		58.5	

NOISE MONITORING DATA
Range A (5.56)
15 October 2001
1000 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	50	488	22	474	382	2	Site Dropped	15	Unit Down
Monitoring Event Mean APeak	87.1	90.9	87.7	90.8	89.7	90.8		86.1	
Standard Deviation Event APeak	1.7	4.4	1.9	4.3	3.4	4.4		0.7	
85-95	50	395	22	390	347	2		15	
95-105	0	93	0	82	35	0		0	
105-115	0	0	0	2	0	0		0	
115-125	0	0	0	0	0	0		0	
≥125	0	0	0	0	0	0		0	
Monitoring ASEL Total	72.8	92	72.2	91.9	89.5	64.6		72.6	
Monitoring Event Mean ASEL	55.4	63.1	58.4	63.3	62.5	60.8		60.4	
Standard Deviation Event ASEL	1.9	3.8	1.9	3.6	3	4		1.8	
40-50	0	0	0	0	0	0		0	
50-60	49	101	18	72	70	1		8	
60-70	1	357	4	377	309	1		7	
70-80	0	30	0	25	3	0		0	
80-90	0	0	0	0	0	0		0	
90-100	0	0	0	0	0	0		0	
>100	0		0	0	0	0		0	

TL=Trigger Level

Range C (12 guage/45 cal)
17 October 2001



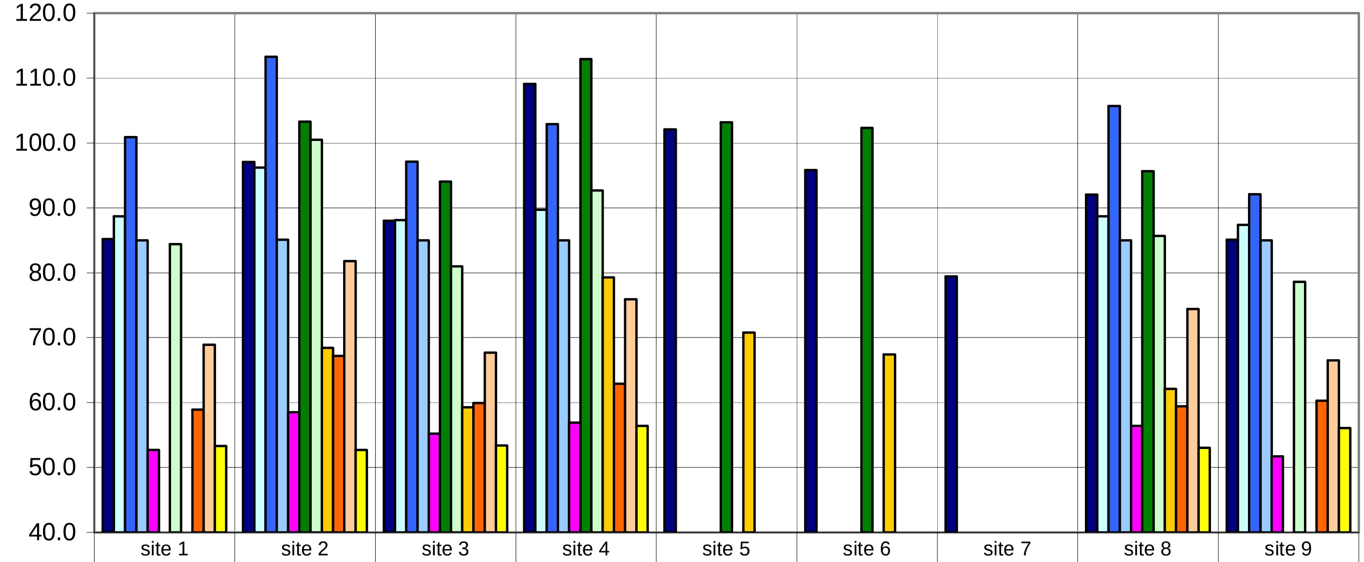
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	85.2	97.1	88.0	109.1	102.1	95.8	79.4	92.0	85.1
Monitoring Event Mean APeak	87.9	95.5	87.8	90.2	88.9	86.4		90.5	89.2
Monitoring Event Max APeak	99.2	109.9	95.8	108.5	95.5	86.9		104.0	101.1
Monitoring Event Min APeak	85.0	85.1	85.0	85.0	85.7	85.6		85.0	85.0
LEQ (Monitoring Event & Amb.)	43.5	52.3	45.2	48.2	47.1	55.8		48.6	46.6
SARNAM ASEL Total	-100.0	103.3	94.1	112.9	103.2	102.3	-100.0	95.7	-100.0
Monitoring ASEL Total	80.0	99.1	78.5	92.1	74.1	74.0		89.2	86.8
SARNAM Event ASEL	-100.0	68.4	59.3	79.3	70.8	67.4	-100.0	62.1	-100.0
Monitoring Event Mean ASEL	57.7	65.2	57.9	60.9	61.3	68.0		60.6	62.3
Monitoring Event Max ASEL	68.3	80.2	68.4	77.6	65.9	68.3		72.4	72.5
Monitoring Event Min ASEL	51.1	51.3	51.5	52.9	57.3	67.4		49.1	55.3

NOISE MONITORING DATA
Range C (12 guage/45 cal)
17 October 2001
3200 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	125	1202	80	744	17	4	Site Dropped	503	210
Monitoring Event Mean APeak	87.9	95.5	87.8	90.2	88.9	86.4		90.5	89.2
Standard Deviation Event APeak	2.7	5.3	2.8	4.1	2.5	0.6		3.7	3.1
85-95	122	524	78	641	16	4		440	196
95-105	3	644	2	100	1	0		63	14
105-115	0	34	0	3	0	0		0	0
115-125	0	0	0	0	0	0		0	0
≥125	0	0	0	0	0	0		0	0
Monitoring ASEL Total	80	99.1	78.5	92.1	74.1	74		89.2	86.8
Monitoring Event Mean ASEL	57.7	65.2	57.9	60.9	61.3	68		60.6	62.3
Standard Deviation Event ASEL	3.2	5.2	3.4	4	2.1	0.4		3.5	3.2
40-50	0	0	0	0	0	0		1	0
50-60	97	200	61	363	6	0		234	47
60-70	28	781	19	366	11	4		262	160
70-80	0	220	0	15	0	0		6	3
80-90	0	1	0	0	0	0		0	0
90-100	0	0	0	0	0	0		0	0
>100	0	0	0	0	0	0		0	0

TL=Trigger Level

Range C (12 guage/45 cal)
18 October 2001



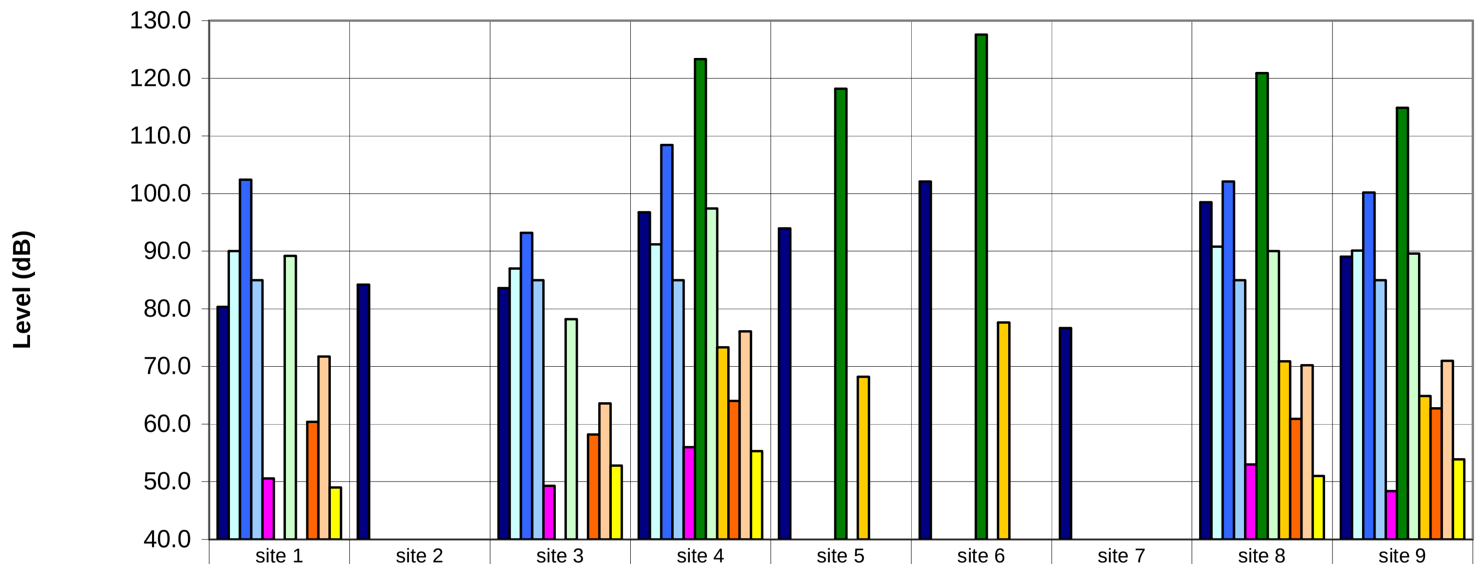
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	85.2	97.1	88.0	109.1	102.1	95.8	79.4	92.0	85.1
Monitoring Event Mean APeak	88.7	96.2	88.1	89.7				88.7	87.4
Monitoring Event Max APeak	100.9	113.3	97.1	102.9				105.7	92.1
Monitoring Event Min APeak	85.0	85.1	85.0	85.0				85.0	85.0
LEQ (Monitoring Event & Amb.)	52.7	58.5	55.2	56.9				56.4	51.7
SARNAM ASEL Total	-100.0	103.3	94.1	112.9	103.2	102.3	-100.0	95.7	-100.0
Monitoring ASEL Total	84.4	100.5	81.0	92.7				85.7	78.6
SARNAM Event ASEL	-100.0	68.4	59.3	79.3	70.8	67.4	-100.0	62.1	-100.0
Monitoring Event Mean ASEL	58.9	67.2	59.9	62.9				59.4	60.3
Monitoring Event Max ASEL	68.9	81.8	67.7	75.9				74.4	66.5
Monitoring Event Min ASEL	53.3	52.7	53.4	56.4				53.0	56.1

NOISE MONITORING DATA
Range C (12 guage/45 cal)
18 October 2001
3200 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	273	1175	243	691	<TL	<TL	Site Dropped	306	59
Monitoring Event Mean APeak	88.7	96.2	88.1	89.7				88.7	87.4
Standard Deviation Event APeak	3	5.4	2.7	3.6				3.2	2
85-95	262	509	239	620				287	59
95-105	11	597	4	71				18	0
105-115	0	69	0	0				1	0
115-125	0	0	0	0				0	0
≥125	0	0	0	0				0	0
Monitoring ASEL Total	84.4	100.5	81	92.7				85.7	78.6
Monitoring Event Mean ASEL	58.9	67.2	59.9	62.9				59.4	60.3
Standard Deviation Event ASEL	2.9	4.6	2.9	3.4				3.2	2.3
40-50	0	0	0	0				0	0
50-60	190	42	137	162				188	26
60-70	83	819	106	514				117	33
70-80	0	310	0	15				1	0
80-90	0	4	0	0				0	0
90-100	0	0	0	0				0	0
>100	0	0	0	0				0	0

TL=Trigger Level

Range C (5.56)
20 October 2001



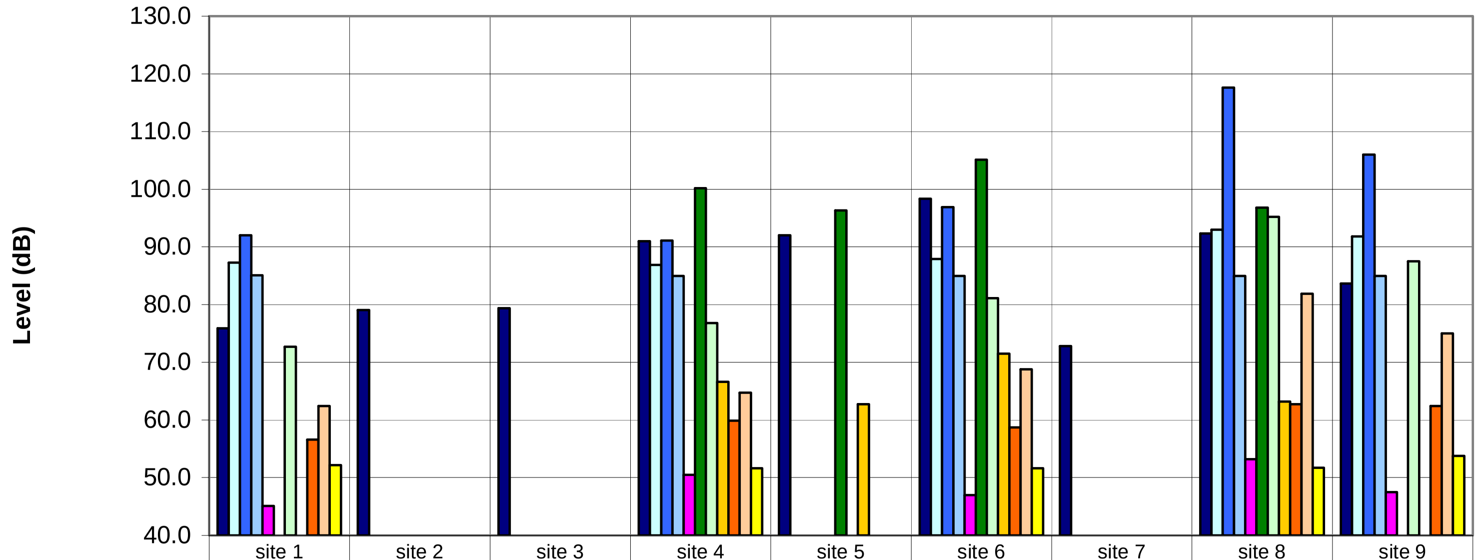
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	80.3	84.2	83.6	96.7	94.0	102.1	76.7	98.5	89.1
Monitoring Event Mean APeak	90.0		87.0	91.2				90.8	90.1
Monitoring Event Max APeak	102.4		93.2	108.4				102.1	100.2
Monitoring Event Min APeak	85.0		85.0	85.0				85.0	85.0
LEQ (Monitoring Event & Amb.)	50.6		49.3	56.0				53.0	48.4
SARNAM ASEL Total	-100.0	-100.0	-100.0	123.3	118.2	127.6	-100.0	120.9	114.9
Monitoring ASEL Total	89.2		78.2	97.4				90.0	89.6
SARNAM Event ASEL	-100.0	-100.0	-100.0	73.3	68.2	77.6	-100.0	70.9	64.9
Monitoring Event Mean ASEL	60.4		58.2	64.0				60.9	62.7
Monitoring Event Max ASEL	71.7		63.6	76.1				70.2	71.0
Monitoring Event Min ASEL	49.0		52.8	55.3				51.0	53.9

NOISE MONITORING DATA
Range C (5.56)
20 October 2001
100080 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	481	Unit Down	88	1626	<TL	<TL	Site Dropped	581	359
Monitoring Event Mean APeak	90		87	91.2				90.8	90.1
Standard Deviation Event APeak	4		1.9	4.1				3.6	3.1
85-95	412		88	1329				503	332
95-105	69		0	292				78	27
105-115	0		0	5				0	0
115-125	0		0	0				0	0
≥125	0		0	0				0	0
Monitoring ASEL Total	82.9		78.2	97.4				90	85.4
Monitoring Event Mean ASEL	60.4		58.2	64				60.9	62.7
Standard Deviation Event ASEL	4		2.1	3.4				3.6	3.5
40-50	1		0	0				0	0
50-60	258		72	186				241	89
60-70	222		16	1376				339	267
70-80	5		0	64				1	3
80-90	0		0	0				0	0
90-100	0		0	0				0	0
>100	0		0	0				0	0

TL=Trigger Level

Range A (9mm)
22 October 2001



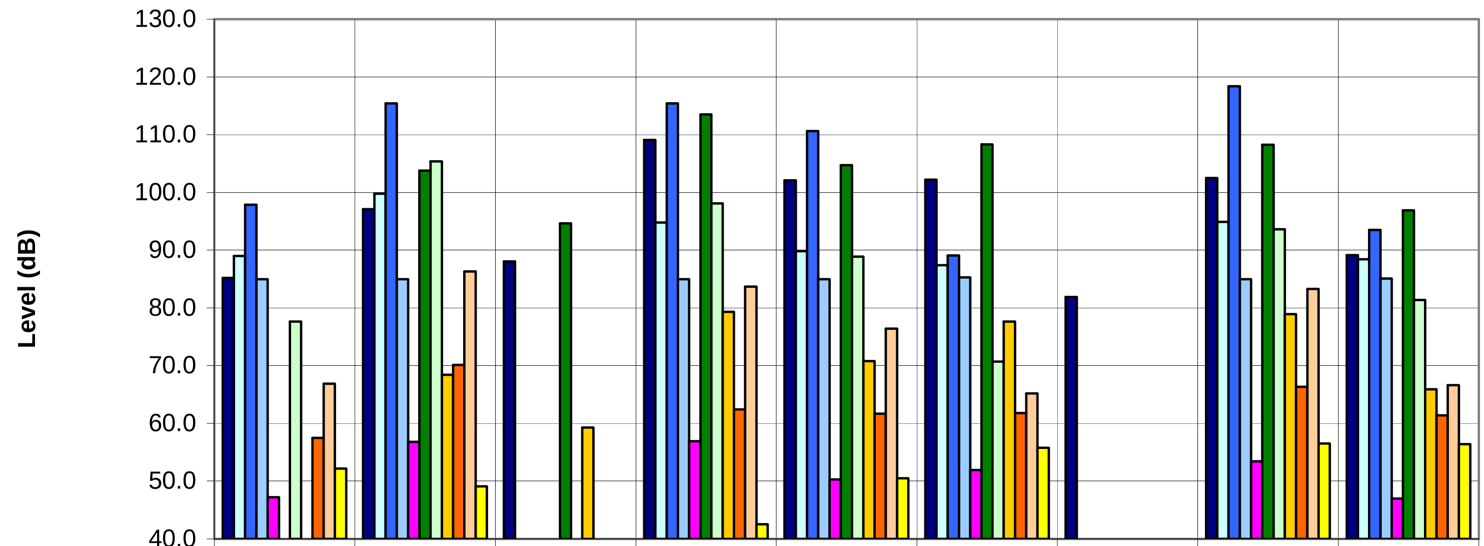
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	75.9	79.0	79.4	91.0	92.0	98.3	72.8	92.4	83.6
Monitoring Event Mean APeak	87.3			86.9		87.9		93.0	91.8
Monitoring Event Max APeak	92.0			91.1		96.9		117.6	106.0
Monitoring Event Min APeak	85.1			85.0		85.0		85.0	85.0
LEQ (Monitoring Event & Amb.)	45.1			50.5		47.0		53.2	47.5
SARNAM ASEL Total	-100.0	-100.0	-100.0	100.2	96.3	105.1	-100.0	96.8	-100.0
Monitoring ASEL Total	72.7			76.8		81.1		95.2	87.5
SARNAM Event ASEL	-100.0	-100.0	-100.0	66.6	62.7	71.5	-100.0	63.2	-100.0
Monitoring Event Mean ASEL	56.6			59.9		58.7		62.7	62.4
Monitoring Event Max ASEL	62.4			64.7		68.8		81.9	75.0
Monitoring Event Min ASEL	52.2			51.6		51.6		51.7	53.8

NOISE MONITORING DATA
Range C (5.56)
22 October 2001
2300 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	34	Unit Down	<TL	38	<TL?	126	Site Dropped	690	202
Monitoring Event Mean APeak	87.3			86.9		87.9		93	89.5
Standard Deviation Event APeak	1.9			1.7		2.7		6	4
85-95	34			38		124		453	182
95-105	0			0		2		215	19
105-115	0			0		0		21	1
115-125	0			0		0		0	0
≥125	0			0		0		0	0
Monitoring ASEL Total	72.7			76.8		81.1		95.2	87.5
Monitoring Event Mean ASEL	56.6			59.9		58.7		62.7	62.4
Standard Deviation Event ASEL	2.7			3.2		3.3		5.4	3.9
40-50	0			0		0		0	0
50-60	31			21		83		295	60
60-70	3			17		43		395	135
70-80	0			0		0		68	7
80-90	0			0		0		1	0
90-100	0			0		0		0	0
>100	0			0		0		0	0

TL=Trigger Level

Range A (5.56), Range B (5.56), Range C (12 guage/45 cal)
24 October 2001



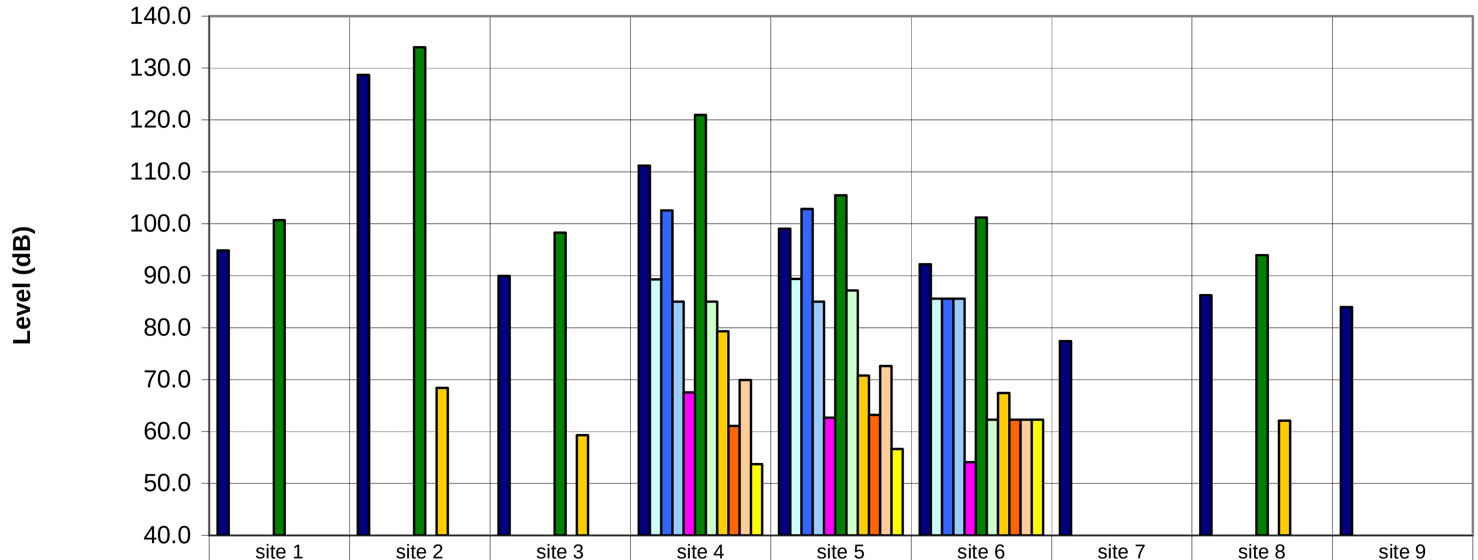
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	85.2	97.1	88.0	109.1	102.1	102.2	81.9	102.5	89.2
Monitoring Event Mean APeak	89.0	99.8		94.8	89.8	87.4		94.9	88.4
Monitoring Event Max APeak	97.9	115.4		115.4	110.6	89.1		118.4	93.5
Monitoring Event Min APeak	85.0	85.0		85.0	85.0	85.3		85.0	85.1
LEQ (Monitoring Event & Amb.)	47.2	56.8		56.9	50.3	51.9		53.4	47.0
SARNAM ASEL Total	-100.0	103.8	94.6	113.5	104.7	108.3	-100.0	108.3	96.9
Monitoring ASEL Total	77.6	105.4		98.1	88.9	70.7		93.6	81.4
SARNAM Event ASEL	-100.0	68.4	59.3	79.3	70.8	77.6	-100.0	78.9	65.9
Monitoring Event Mean ASEL	57.5	70.1		62.4	61.7	61.8		66.3	61.4
Monitoring Event Max ASEL	66.9	86.3		83.7	76.4	65.2		83.3	66.6
Monitoring Event Min ASEL	52.2	49.1		42.5	50.5	55.8		56.5	56.4

NOISE MONITORING DATA
Range A (5.56), Range B (5.56), Range C (12 guage/45 cal)
24 October 2001
4600 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	69	1503	<TL	1496	296	6	Site Dropped	326	84
Monitoring Event Mean APeak	89	99.8		94.8	89.8	87.4		94.9	88.4
Standard Deviation Event APeak	3.2	6.4		5.7	4.6	1.5		5.2	2.3
85-95	66	1386		807	262	6		169	84
95-105	3	861		618	28	0		148	0
105-115	0	315		70	6	0		8	0
115-125	0	1		1	0	0		1	0
≥125	0	0		0	0	0		0	0
Monitoring ASEL Total	77.6	105.4		98.1	88.9	70.7		93.6	81.4
Monitoring Event Mean ASEL	57.5	70.1		62.4	61.7	61.8		66.3	61.4
Standard Deviation Event ASEL	3.7	5.8		5.6	4.1	3.9		3.9	2.5
40-50	0	2		1	0	0		0	0
50-60	51	72		561	107	2		14	27
60-70	18	612		790	177	4		258	57
70-80	0	459		141	12	0		53	0
80-90	0	58		3	0	0		1	0
90-100	0	0		0	0	0		0	0
>100	0	0		0	0	0		0	0

TL=Trigger Level

Range C (12 guage/45 cal)
25 October 2001



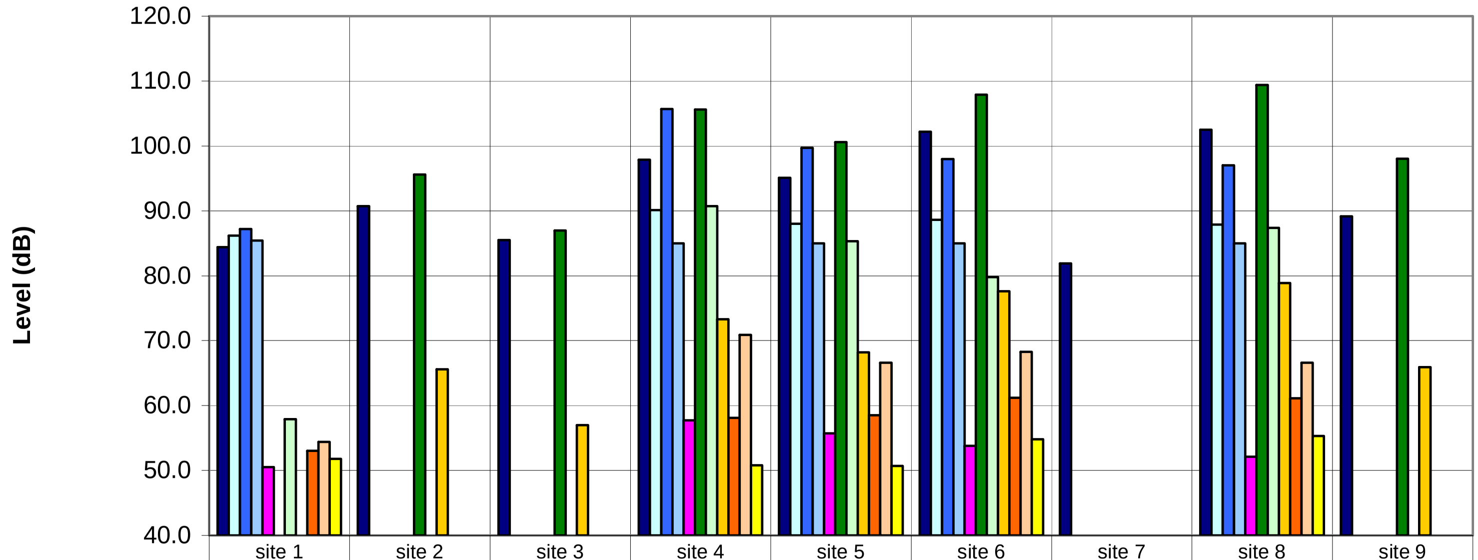
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	94.9	128.7	90.0	111.2	99.1	92.2	77.4	86.3	84.0
Monitoring Event Mean APeak				89.3	89.4	85.6			
Monitoring Event Max APeak				102.6	102.9	85.6			
Monitoring Event Min APeak				85.0	85.0	85.6			
LEQ (Monitoring Event & Amb.)				67.5	62.7	54.1			
SARNAM ASEL Total	100.7	134.0	98.3	121.0	105.5	101.2	-100.0	94.0	-100.0
Monitoring ASEL Total				85.0	87.2	62.3			
SARNAM Event ASEL	-100.0	68.4	59.3	79.3	70.8	67.4	-100.0	62.1	-100.0
Monitoring Event Mean ASEL				61.1	63.2	62.3			
Monitoring Event Max ASEL				69.9	72.6	62.3			
Monitoring Event Min ASEL				53.7	56.6	62.3			

NOISE MONITORING DATA
Range C (12 guage/45 cal)
25 October 2001
6800 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	<TL	<TL	<TL	192	196	1	Site Dropped	<TL	<TL
Monitoring Event Mean APeak				89.3	89.4	85.6			
Standard Deviation Event APeak				3.4	3.5	0			
85-95				177	181	1			
95-105				15	15	0			
105-115				0	0	0			
115-125				0	0	0			
≥125				0	0	0			
Monitoring ASEL Total				85	87.2	62.3			
Monitoring Event Mean ASEL				61.1	63.2	62.3			
Standard Deviation Event ASEL				3	3	0			
40-50				0	0	0			
50-60				71	28	0			
60-70				121	162	1			
70-80				0	6	0			
80-90				0	0	0			
90-100				0	0	0			
>100				0	0	0			

TL=Trigger Level

Range A (5.56), Range B (5.56)
26 October 2001



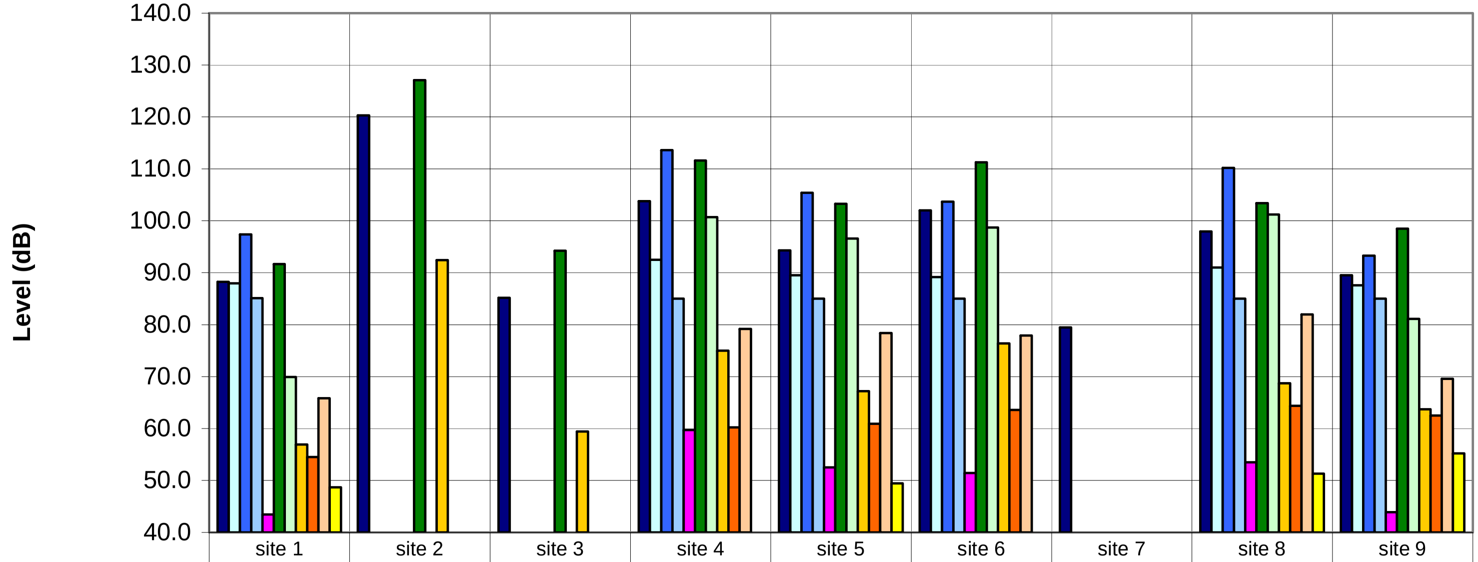
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	84.4	90.7	85.5	97.9	95.1	102.2	81.9	102.5	89.2
Monitoring Event Mean APeak	86.2			90.1	88.0	88.6		87.9	
Monitoring Event Max APeak	87.2			105.7	99.7	98.0		97.0	
Monitoring Event Min APeak	85.4			85.0	85.0	85.0		85.0	
LEQ (Monitoring Event & Amb.)	50.5			57.7	55.7	53.8		52.1	
SARNAM ASEL Total	-100.0	95.6	87.0	105.6	100.6	107.9	-100.0	109.4	98.0
Monitoring ASEL Total	57.9			90.7	85.3	79.8		87.4	
SARNAM Event ASEL	-100.0	65.6	57.0	73.3	68.2	77.6	-100.0	78.9	65.9
Monitoring Event Mean ASEL	53.0			58.1	58.5	61.2		61.1	
Monitoring Event Max ASEL	54.4			70.9	66.6	68.3		66.6	
Monitoring Event Min ASEL	51.8			50.8	50.7	54.8		55.3	

NOISE MONITORING DATA
Range A (5.56), Range B (5.56)
26 October 2001
1800 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	3	<TL	<TL	1261	408	58	Site Dropped	395	<TL
Monitoring Event Mean APeak	86.2			90.1	88	88.6		87.9	
Standard Deviation Event APeak	0.9			3.9	2.5	3		2.3	
85-95	3			1099	398	55		390	
95-105	0			160	10	3		5	
105-115	0			2	0	0		0	
115-125	0			0	0	0		0	
≥125	0			0	0	0		0	
Monitoring ASEL Total	57.9			58.1	58.5	79.8		87.4	
Monitoring Event Mean ASEL	53			90.7	85.3	61.2		61.1	
Standard Deviation Event ASEL	1.3			3.3	2.5	2.9		1.8	
40-50	0			0	0	0		0	
50-60	3			946	293	20		116	
60-70	0			311	115	38		279	
70-80	0			4	0	0		0	
80-90	0			0	0	0		0	
90-100	0			0	0	0		0	
>100	0			0	0	0		0	

TL=Trigger Level

Range A (7.62), Range D (9mm)
27 October 2001



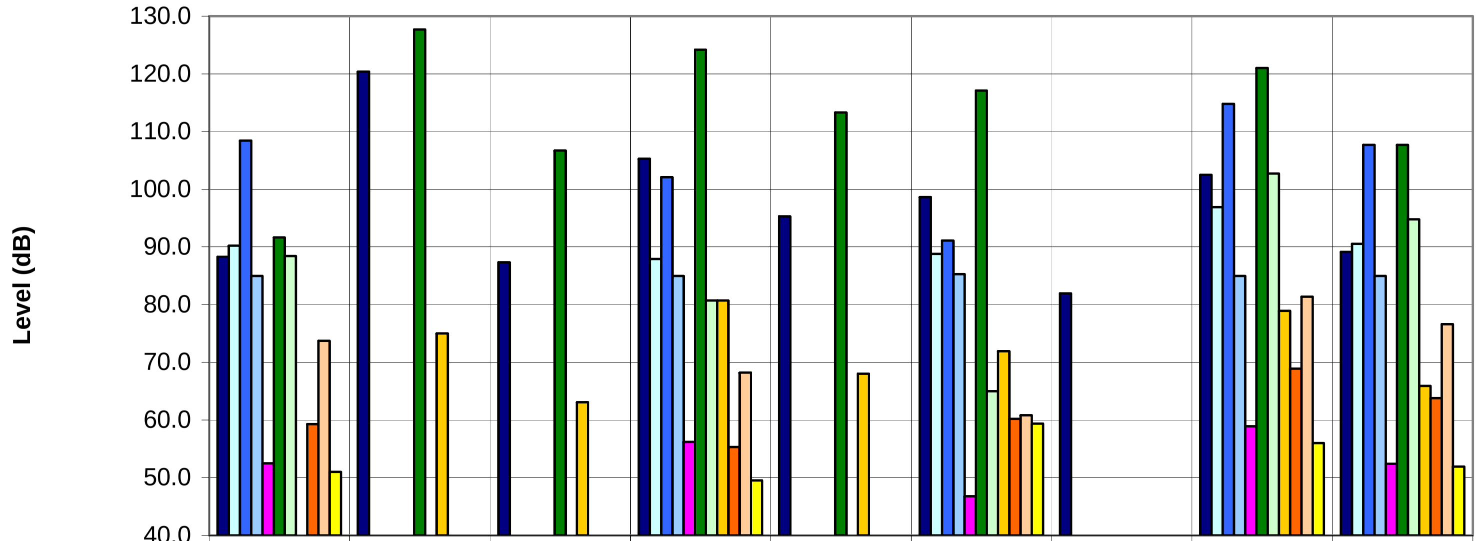
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	88.3	120.3	85.2	103.8	94.3	102.0	79.5	98.0	89.5
Monitoring Event Mean APeak	88.0			92.5	89.5	89.2		91.0	87.6
Monitoring Event Max APeak	97.4			113.6	105.4	103.7		110.2	93.3
Monitoring Event Min APeak	85.1			85.0	85.0	85.0		85.0	85.0
LEQ (Monitoring Event & Amb.)	43.4			59.7	52.5	51.4		53.5	43.9
SARNAM ASEL Total	91.7	127.1	94.2	111.6	103.3	111.3	-100.0	103.4	98.5
Monitoring ASEL Total	69.9			100.7	96.6	98.7		101.2	81.1
SARNAM Event ASEL	56.9	92.4	59.4	75.0	67.2	76.4	-100.0	68.7	63.7
Monitoring Event Mean ASEL	54.5			60.2	60.9	63.6		64.4	62.5
Monitoring Event Max ASEL	65.8			79.2	78.4	77.9		82.0	69.6
Monitoring Event Min ASEL	48.7			29.9	49.4	34.6		51.3	55.2

NOISE MONITORING DATA
Range A (7.62), Range D (9mm)
27 October 2001
6000 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	22	Unit Down	<TL	3837	1467	1557	Site Dropped	1719	49
Monitoring Event Mean APeak	88			92.5	89.5	89.2		91	87.6
Standard Deviation Event APeak	2.9			5.6	4	3.5		4.9	2.1
85-95	21			2664	1306	1421		1337	49
95-105	1			1080	160	136		375	0
105-115	0			93	1	0		7	0
115-125	0			0	0	0		0	0
≥125	0			0	0	0		0	0
Monitoring ASEL Total	69.9			100.7	96.6	98.7		101.2	81.1
Monitoring Event Mean ASEL	54.5			60.2	60.9	63.3		64.4	62.5
Standard Deviation Event ASEL	3.4			5.8	5.3	5.5		5.5	3.9
40-50	1			13	3	0		0	0
50-60	20			2150	713	490		351	16
60-70	1			1379	644	850		1077	33
70-80	0			294	107	216		280	0
80-90	0			0	0	0		11	0
90-100	0			0	0	0		0	0
>100	0			0	0	0		0	0
<40	0			1	0	1		0	0

TL=Trigger Level

Range B (5.56), Range C (5.56)
28 October 2001



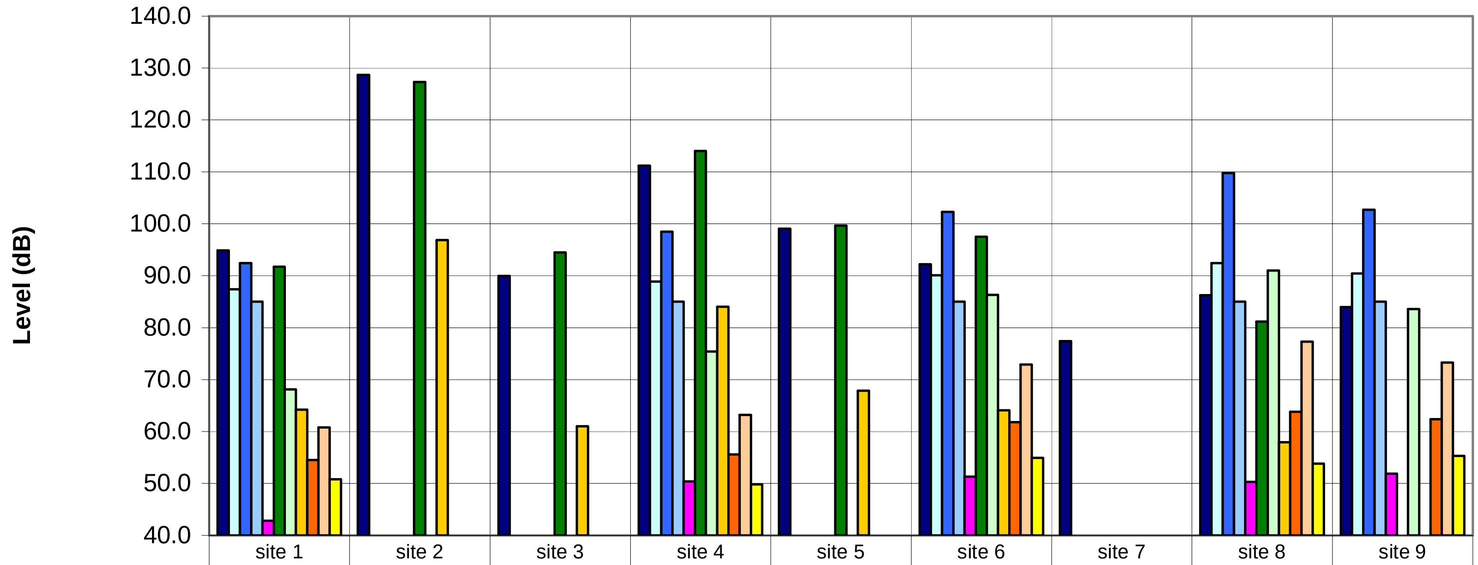
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	88.3	120.4	87.3	105.3	95.3	98.7	81.9	102.5	89.2
Monitoring Event Mean APeak	90.2			87.9		88.8		96.9	90.5
Monitoring Event Max APeak	108.4			102.1		91.1		114.8	107.7
Monitoring Event Min APeak	85.0			85.0		85.3		85.0	85.0
LEQ (Monitoring Event & Amb.)	52.5			56.2		46.8		58.9	52.4
SARNAM ASEL Total	91.7	127.7	106.7	124.2	113.3	117.1	-100.0	121.0	107.7
Monitoring ASEL Total	88.4			80.7		65.0		102.7	94.8
SARNAM Event ASEL	-100.0	75.0	63.1	80.7	68.0	71.9	-100.0	78.9	65.9
Monitoring Event Mean ASEL	59.3			55.3		60.2		68.9	63.8
Monitoring Event Max ASEL	73.7			68.2		60.8		81.4	76.6
Monitoring Event Min ASEL	51.0			49.5		59.4		56.0	51.9

NOISE MONITORING DATA
Range B (5.56), Range C (5.56)
28 October 2001
33657 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	526	<TL	<TL	276	Unit Down	3	Site Dropped	1378	899
Monitoring Event Mean APeak	90.2			87.9		88.8		96.9	90.5
Standard Deviation Event APeak	4.1			2.9		3.1		6	3.9
85-95	450			266		3		482	781
95-105	75			10		0		770	116
105-115	1			0		0		126	2
115-125	0			0		0		0	0
≥125	0			0		0		0	0
Monitoring ASEL Total	88.4			80.7		65		102.7	94.8
Monitoring Event Mean ASEL	859.3			55.3		60.2		68.9	63.8
Standard Deviation Event ASEL	3.8			2.7		0.7		4.8	3.4
40-50	0			1		0		0	0
50-60	308			260		1		64	110
60-70	217			15		2		717	752
70-80	1			0		0		595	37
80-90	0			0		0		2	0
90-100	0			0		0		0	0
>100	0			0		0		0	0

TL=Trigger Level

Range D (12 guage/45 cal)
30 October 2001



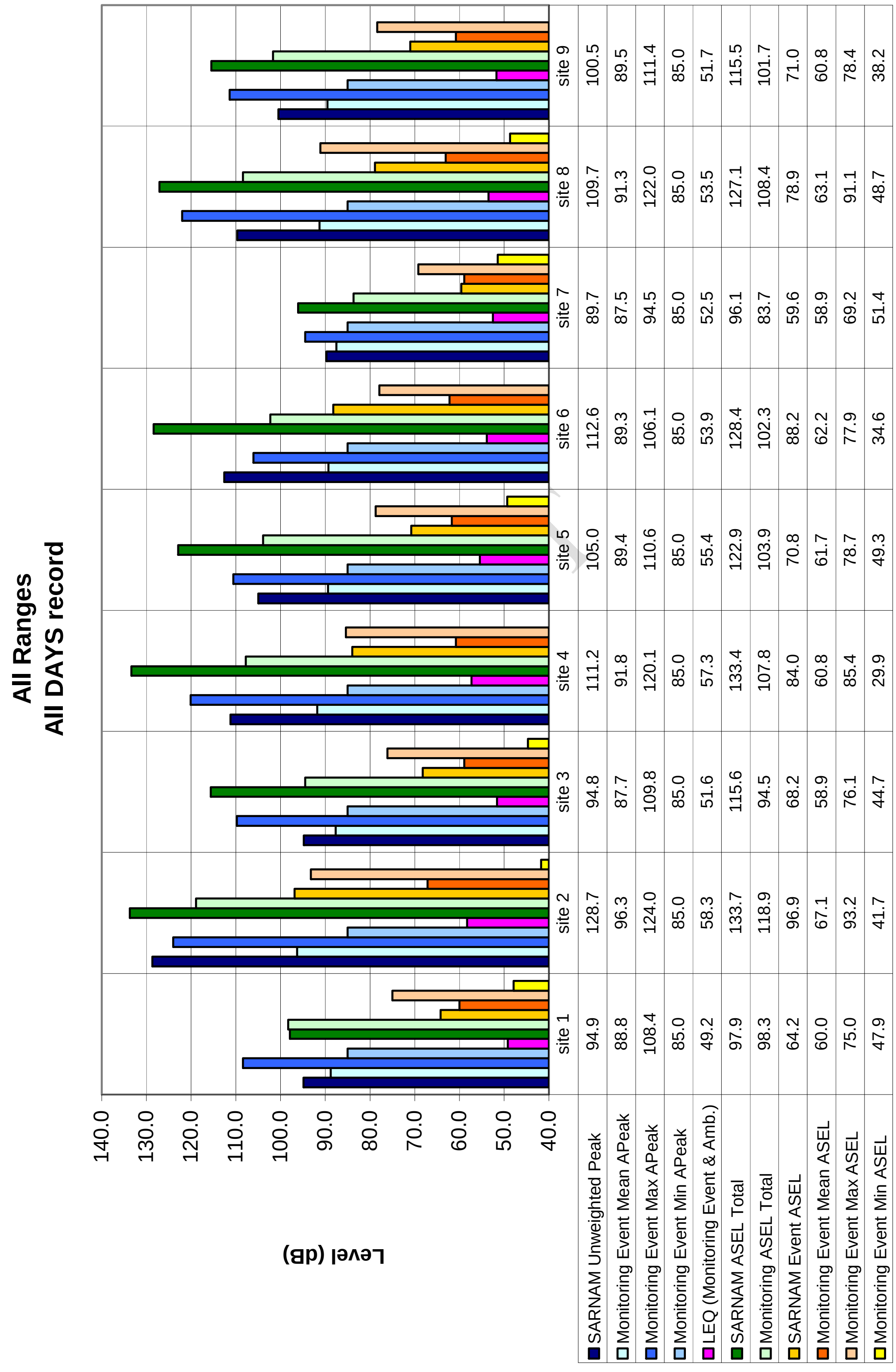
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	94.9	128.7	90.0	111.2	99.1	92.2	77.4	86.3	84.0
Monitoring Event Mean APeak	87.4			88.9		90.1		92.4	90.4
Monitoring Event Max APeak	92.4			98.5		102.3		109.8	102.7
Monitoring Event Min APeak	85.0			85.0		85.0		85.0	85.0
LEQ (Monitoring Event & Amb.)	42.8			50.4		51.3		50.3	51.9
SARNAM ASEL Total	91.8	127.3	94.5	114.0	99.7	97.5	-100.0	81.2	-100.0
Monitoring ASEL Total	68.1			75.4		86.3		91.0	83.6
SARNAM Event ASEL	64.2	96.9	61.0	84.0	67.9	64.1	-100.0	58.0	-100.0
Monitoring Event Mean ASEL	54.5			55.6		61.8		63.8	62.4
Monitoring Event Max ASEL	60.8			63.2		72.9		77.3	73.3
Monitoring Event Min ASEL	50.8			49.8		54.9		53.8	55.3

NOISE MONITORING DATA
Range D (12 guage/45 cal)
30 October 2001
2310 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	19	<TL	<TL	72	Unit Down	206	Site Dropped	300	74
Monitoring Event Mean APeak	87.4			88.9		90.1		92.4	90.4
Standard Deviation Event APeak	1.8			3.5		3.6		5.2	4.5
85-95	19			68		183		209	60
95-105	0			4		23		84	14
105-115	0			0		0		7	0
115-125	0			0		0		0	0
≥125	0			0		0		0	0
Monitoring ASEL Total	68.1			75.4		86.3		91	83.6
Monitoring Event Mean ASEL	54.5			55.6		61.8		63.8	62.4
Standard Deviation Event ASEL	2.5			3.2		3.2		4.5	4.4
40-50	0			1		0		0	0
50-60	18			64		65		63	23
60-70	1			7		140		210	44
70-80	0			0		1		27	7
80-90	0			0		0		0	0
90-100	0			0		0		0	0
>100	0			0		0		0	0

TL=Trigger Level

Appendix E
Total Annual Noise Data



	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
SARNAM Unweighted Peak	94.9	128.7	94.8	111.2	105.0	112.6	89.7	109.7	100.5
Monitoring Event Mean APeak	88.8	96.3	87.7	91.8	89.4	89.3	87.5	91.3	89.5
Monitoring Event Max APeak	108.4	124.0	109.8	120.1	110.6	106.1	94.5	122.0	111.4
Monitoring Event Min APeak	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0
LEQ (Monitoring Event & Amb.)	49.2	58.3	51.6	57.3	55.4	53.9	52.5	53.5	51.7
SARNAM ASEL Total	97.9	133.7	115.6	133.4	122.9	128.4	96.1	127.1	115.5
Monitoring ASEL Total	98.3	118.9	94.5	107.8	103.9	102.3	83.7	108.4	101.7
SARNAM Event ASEL	64.2	96.9	68.2	84.0	70.8	88.2	59.6	78.9	71.0
Monitoring Event Mean ASEL	60.0	67.1	58.9	60.8	61.7	62.2	58.9	63.1	60.8
Monitoring Event Max ASEL	75.0	93.2	76.1	85.4	78.7	77.9	69.2	91.1	78.4
Monitoring Event Min ASEL	47.9	41.7	44.7	29.9	49.3	34.6	51.4	48.7	38.2

NOISE MONITORING DATA
Range A (5.56/7.62/9mm/45 cal/50 cal/12 guage/22 LR), Range B(5.56), Range C(5.56/9mm/45 cal/12 guage), Range D(9mm/45 cal/12 guage)
23 May - 30 October 2001
310874 Rounds (RFMSS)
Trigger 85 dBAPeak

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Number of Monitoring Events	4339	40732	1881	21155	9393	5709	243	13666	7426
Monitoring Event Mean APeak	88.8	96.3	87.7	91.8	89.4	89.3	87.5	91.3	89.5
Standard Deviation Event APeak	3.4	7.6	2.7	5.2	3.6	3.5	2.1	5.3	3.5
85-95	4044	19706	1845	15892	8590	5256	243	10593	6809
95-105	292	14821	36	4866	787	452	0	2783	609
105-115	3	5775	2	388	16	1	0	273	8
115-125	0	430	0	9	0	0	0	17	0
≥125	0	0	0	0	0	0	0	0	0
Monitoring ASEL Total	98.3	118.9	94.5	107.8	103.9	102.3	83.7	108.4	101.7
Monitoring Event Mean ASEL	60	67.1	58.9	60.8	61.7	62.2	58.9	63.1	60.8
Standard Deviation Event ASEL	3.8	6.7	4.1	5.2	4.4	4.5	2.7	5	4.3
40-50	5	10	5	42	5	2	0	2	43
50-60	2273	5588	1263	10222	3625	1878	168	4036	3169
60-70	2018	22577	547	9773	5392	3519	75	8194	4079
70-80	43	10835	66	1100	371	309	0	1398	134
80-90	0	1711	0	16	0	0	0	35	0
90-100	0	11	0	0	0	0	0	1	0
>100	0	0	0	0	0	0	0	0	0

TL=Trigger Level

Appendix F
Noise Costs to the Army

This analysis provides an estimate of the impact of training and testing noise on DoD operating budgets. Not all of these costs can be addressed through use of noise assessment software, and the benefit directly attributable to SARNAM™ would be highly dependent on the situation.

This cost analysis addresses noise types that are Army-unique, which will not receive adequate attention if DoD does not address them. These noise types are helicopter, blast (artillery, armor, detonations), and small arms noise. The cost of dealing with the effects of noise on threatened and endangered species is included here, since the assessment of such effects relies heavily on the tools and technology developed by the Army noise R&D program. Effects of noise on domestic animals are also included here, in damage claims. Costs are calculated based on damage claims, complaint handling, range and firing point closures, NEPA and ONMP assessment costs, acquisition of new land, and impact on training and testing capability. Training and testing capability impacts include loss of training hours and loss of use of training acres, rescheduling training and testing, modifying training procedures, and the consequences of inadequate training. All costs are estimated in terms of FY03 dollar value, not adjusted for inflation.

<u>DAMAGE CLAIMS.</u> Each year, damage claims directly attributable to noise, with a total value of about $16M, are submitted to the Army Claims Service (ACS). About $0.25M are paid each year by the ACS. This does not include claims smaller than $25,000, which are handled locally. It is estimated that total damage claims that are paid Army-wide amount to about $900K per year. This does not include the processing cost, which can be estimated to average about 60 man-hours at $63/hr = $3,780 each. If the total number of claims is estimated to be 800 claims per year, the estimated processing cost is $3,024K. Thus the total cost of damage claims is about <u>$3,924K</u> per year. With improved technology, better tech transfer, and better coordination via a user group, it is estimated that this cost could be reduced by 20%. Without a noise program, there would be a lack of information regarding validity of noise damage claims, many invalid claims would be paid, and valid ones would be denied and would lead to expensive litigation. The cost could rapidly escalate.

<u>COMPLAINT HANDLING.</u> Haphazard handling of complaints results in damaged community relations, which results in escalated complaints and many more resources and man-hours spent dealing with the consequences. The time per complaint in the aggregate can easily amount to 30 man-hours at $63/hr = $1,890. A typical installation may receive 30 complaints per year. This occurs at perhaps 100 installations, including ARNG. Thus the total annual cost can be evaluated as $1,890 x 30 x 100 = <u>$5,670K</u>. Improved methods, using a tested complaint management system based on experience, and disseminated via improved technology transfer, can reduce costs by an estimated 20%. Each complaint can be handled more efficiently and also more appropriately, avoiding escalation. Without the program, and without effective technology transfer, the losses would grow with time as more planning and design mistakes accumulate and result in more complaints.

RANGE CLOSURE: Ranges have been closed and use of firing points discontinued because of noise. A $19M range in Wielflecken, Germany, and a $3M small arms range at Camp Butner, North Carolina, are examples in the past several years. If it is estimated that a range is closed on the average once every two years, and must be replaced, at an average cost of $10.6M, one arrives at a cost per year of $5,300K. Firing points cost about $325,000 to plan and construct. Estimate a loss of 10 firing points per year = $3,250K. The total cost of losing the use of ranges and firing points is thus estimated to be $8,550K per year. This loss could be reduced by an estimated 20% by proper siting and design of new ranges and by improved management of existing ranges. Without the program, without effective technology transfer, and without a user group to help disseminate information and technology and lessons learned, losses would grow with time as more planning, design and operations management mistakes accumulate, resulting in the closure of more ranges and firing points.

LAND ACQUISITION AND ENCROACHMENT: Land is often acquired to mitigate severe noise problems. Assume land to have an average value (improved and unimproved) of $6,400 (range of $1,000 to $150,000) per acre. Most land acquisitions are motivated by several factors; the most common are noise and TES. Fifty percent of land acquisition cost is attributed to noise. Many erroneously believe that the military does not currently acquire land. In fact, the Army, U.S. Marine Corps, and National Guard acquire more than 2,500 acres per year. Recent examples include Camp Dodge, Iowa; Fort Polk, Louisiana; Fort Campbell, Kentucky (130 acres near the Sabre Army Heliport); and Fort Bragg/Pope Air Force Base, North Carolina (near Simmons Army Airfield, 100 acres and 10,000 acres). Other installations are considering substantial land acquisitions to avoid encroachment and accompanying noise problems; at least one of these may amount to as much as $150M. Using the smaller, concrete figures, one calculates 2,500 x 6.4K x .5 = $8,000K per year. With improved methods of noise management, the cost of land acquisition could be decreased. If one assumes that improved noise management and mitigation technology could reduce noise motivation for land acquisition by 20%, one arrives at an overall reduction of about 10%, or $800K per year. Without the noise program, the situation could become much worse. Much more land would be acquired in an attempt to mitigate noise problems.

NEPA AND ONMP ASSESSMENT: The ONMP is mandated by AR200-1. The NEPA Environmental Assessment (EA) and Environmental Impact Statement (EIS) procedures usually show noise to be a leading issue. ERDC/CERL and USACHPPM get many phone calls each year asking for help on these problems. Noise dose assessment software such as NOISEMAP, Blast Noise 2 software (BNOISE2™) and SARNAM™ are essential to assess impacts. A typical ONMP study costs about $50K, and is redone about every 5 years. Significant ONMP studies are done at about 75 installations, for an annual cost of $50K x 75 / 5 = $750K. A typical NEPA study costs $2,200K, about 10% of which can typically be attributed to noise. Such a study is typically needed about every 4 years, at perhaps 100 installations. A cost estimate is thus 2,200 / 4 x .1 x 100 = $5,500K. Total annual cost of preparing the required reports is thus estimated to be $7,900K. This does not include the cost of staff time required to shepherd an ONMP, EA, or EIS through the multi-year process from conception to completion. Assume a man-year of labor costs about $106K. An average ONMP requires perhaps 1/2 man-year of installation staff time, a cost of $53K. An average EA or EIS typically requires much more effort, perhaps a total of three man-years, cost $318K. The staff cost attributable to noise is thus estimated to be ONMP $53K x

75 / 5 + NEPA $318K / 4 x .1 x 100 = $1,590K. Total annual cost is thus $7,840K. With improved technology and transfer of same, including to private contractors who often execute these studies, and to installations so they can be smart buyers, costs can be reduced by at least 20%. Without the program, current tools will quickly become obsolete as new weapons are introduced and as adversaries demand the use of modern sophisticated technology. Calculation of noise contours for installations' noisy operations demands automated calculation tools because of complexity and computational labor. Without such tools, NEPA and ONMP would be unsatisfactory. The consequences are substantial and would grow with time.

REDUCED TRAINING CAPABILITY: Noise insidiously compromises training by preventing some types of training from being carried out because of noise impacts or because of loss of training facilities. An inadequately trained Soldier is at risk, and his combat mission is also put at risk. Estimating the dollar cost of the death of a Soldier is a problematical issue. Estimating the cost of not achieving a combat objective could be extremely large but is also difficult to estimate accurately. To maintain credibility, this estimate is based strictly on the cost of loss of training hours, rescheduling training, and modifying training procedures. An hour of training, for each trainee, including range O&M, support personnel, and equipment, is estimated to cost $110. Total training of 500,000 troops (Army, U. S. Army Reserve, ARNG, and U.S. Marine Corps) may involve on the average 100 hours of noisy training per trainee per year. Such training occurs on at least 45 installations (10 U.S. Army Forces Command, 10 U.S. Army Training and Doctrine Command, 8 ARNG, 5 U.S. Army Materiel Command, and 12 Navy/USMC/U.S. Air Force). The total cost of such noisy training can be estimated according to 500,000 x 100 hrs x $110 = $5,500,000K. Conservatively, if only 5% of this noisy training is compromised by noise impacts, the cost is $275,000K. Testing is often canceled or rescheduled because of possible nose impacts. This is expensive because many dedicated labor costs continue whether or not testing is carried out. It is estimated that these costs are about $3300 per hour at a typical testing range such as Aberdeen Proving Ground, Maryland, or Yuma Proving Ground, Arizona, and that a total of at least 1,000 hours of such costs are experienced each year Army-wide, for an additional cost of $3,300K. Additional hidden costs, particularly transportation costs, accrue due to relocation of testing because of noise. These costs easily amount to an average of $200 per troop each year, for a total of 500,000 x $200 = $100,000K. The total cost of reduced training capability due to noise is thus estimated to be $378,000K per year. With improved noise management, the loss of training hours, and thus the associated monetary loss, can be substantially reduced, by an estimated 20%. Without noise management technology, the impacts of noise on training capability would rapidly grow.

SUMMARY and COST AVOIDANCE: The annual costs of noise problems that result from the response of humans to loud training noise, as estimated in detail above, total to $411,984K per year without accounting for the possible cost of loss of life or unachieved combat objectives. During the period of FY06-FY11 this is a total cost of $2,482M (FY03 $). A 20% reduction in cost, which is realizable by applying noise tools and technology in combination with a proactive public relations effort, is a cost avoidance of about $492,000K.

THREATENED AND ENDANGERED SPECIES SAVINGS: Another problem that endangers training capability is impacts and considerations due to the presence of threatened and endangered species (T&ES) on military lands. Under the Endangered Species Act, regulators are

charged by law with responsibility to protect T&ES. In the absence of definitive data regarding the impact of military activity on T&ES, regulators can make, and indeed have made, decisions that reduce availability of training land. A separate, detailed estimate of the costs associated with the presence of T&ES on Army lands, and the cost avoidance affected by T&ES impacts on R&D, show annual cost avoidance during the period FY06-11 of about $74,000K. Noise is one of three stimuli of concern for T&ES. Since the assessment of noise impacts on T&ES relies heavily on the tools, techniques, and technology developed by the noise R&D program, and is essential to mitigating T&ES impacts on training capability, it is reasonable to claim 33% of the T&ES cost avoidance as a benefit of the noise research. Thus additional cost avoidance amounts to an average annual cost of $24,700K during the period of FY06-11.

<u>NET COST AVOIDANCE:</u> The total cost avoidance resulting from the Environmental Technology Management Plan (ETMP) program of research, development, and implementation of nose tools, techniques, and technology during the period FY06-11 is thus about $516,000K, expressed in FY03 dollars. The total cost of the noise program is about $32,000K in FY01 dollars. The return on investment (ROI) is thus about 16.

Noise Cost Avoidance Worksheet (FY03 $)

CATEGORY	ANNUAL COST ($K)	COST AVOIDANCE ANNUAL ($K)	COST AVOIDANCE FY 06-11 TOTAL ($K)
Damage Claims	3,924	785	4,709
Complaints	5,670	1,134	6,804
Range Closure	8,550	1,710	10,260
Encroachment	8,000	800	4,800
NEPA / ONMP	7,840	1,898	9,738
Reduced Training Capability	378,000	75,600	453,600
Compliance Noise Total	413,634	81,927	491,561
TES Savings (source: TES ETMP)	20,583	4,117	24,700
NET COST AVOIDANCE	432,567	86,043	514,611

<u>INTANGIBLE BENEFITS:</u> An important aspect of encroachment-related noise problems is that it may not be feasible to replace training lands, simply because suitable lands are not available at any price to create a new training facility equivalent to installations such as Fort Carson, Fort Hood, Fort Lewis, Fort Stewart, Fort Benning, etc. Thus, a great value of intelligent noise management is sustaining training capability on existing training lands.

Noise management also produces qualitative benefits. Lower noise levels will result in improved quality of life for both Army personnel and the residents of the region surrounding Army and National Guard installations. Fewer noise problems help to ensure that Army personnel are well-trained, will remain in the Army, and will be able to carry out combat missions with greater effectiveness and reduced losses. An effective and proactive noise management program greatly improves relations with the surrounding community.